POWER

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Banks' Duty

"Believe it or not," a distressing indictment of the banking fraternity hangs heavily over its head. Throughout the period of business decline the bankers have been severely criticized because of their failure to respond to the financial needs of industry. There have been excuses.

While they have lustily risen in their own defense and have received aid in no small degree from the loyal citizens who have supported Federal effort to reestablish financial liquidity, the banks do not yet seem to realize the effect of their past mistakes or that industry has the right to expect constructive support from them now.

It is as though past errors have so destroyed their confidence that they are still afraid to aid in legitimate business to turn the tide.

When a banker unhesitatingly advises a contracting company to use its own available cash on an important power project and simultaneously refuses any participation on the bank's account, one wonders how industry is to get going. And this is only one example.

Is it possible that business is expected to be the tail that wags the dog? Two wrongs do not make a right and lack of a proper conservatism during boom times cannot excuse the banks for an ultra-conservatism when business requires and expects constructive co-operation.

EDITORIALS

Safety Measures in Coal Bunkers

Last week's news contained a report of two men who while working in a pulverized-coal bunker fell and in spite of the safety precautions were, figuratively speaking, drowned in the coal. Such accidents are always unfortunate and emphasize the importance of enforcing safety regulations.

When men work in bunkers containing either pulverized or crushed coal there are two rules that should be followed: No one should enter a bunker containing coal unless attended by another person who should be available for rendering assistance when needed, and life lines and belts should be provided for any one entering a bunker. The belt should be worn, and a rope of sufficient strength to bear his weight should at all times be attached to the belt and fastened to a substantial support on the outside of the bunker.

Safety rules such as these are looked upon as nuisances by the operating force and are therefore frequently difficult to enforce, but unless enforced they are valueless. When necessary, drastic measures are justified to secure compliance with safety measures. Generally, discipline need only be resorted to a few times to secure the full cooperation of those for whom the regulations are intended.

Diesel Units For House Service

Diesel-electric sets are being built by several companies in this country for use on railways either as locomotives or for self-propelling coaches. These sets are light-weight, rugged, high-speed units which do not require, in fact cannot have, rigid foundations. They have given satisfactory service for long periods under rather unfavorable operating conditions.

Why are not such units used in our modern steam central stations for standby house service? They can be started on short notice. They would be wholly independent of the steam generating or distributing system. Since they do not use steam, there would be no problem of fitting them into the station heat balance. Their high efficiency would lead to low operating costs and there would be no standby losses when idle. The units take little space and as they require little foundation, could set in any other convenient location.

Central-station operators may object that this type of equipment is foreign to the steam man and hence liable to be improperly used. Yet these operating men do not hesitate to operate and do the maintenance work on their own automobile engines. It will also be argued that the diesel set is too expensive. This is a question of quantity production. If demands warranted the building of a line of, say, 500-kilowatt units ,the manufacturing costs could be so greatly reduced as to compare favorably with steam equipment.

Diesels have been used successfully for house service abroad. Why not try them in an American plant?

Power First Navigation Later

If recent reports are an indication of difficulties awaiting a treaty between Canada and the United States for developing the St. Lawrence River, then consummation of this pact is something for the distant future. Even after a treaty is negotiated it must obtain legislative sanction in Ottawa and Washington. Approval of a treaty that involves construction of a deep waterway on the St. Lawrence will require large financial appropriations by the two governments before work can be started.

Strong opposition, particularly in Canada, has been registered against a St. Lawrence treaty that involves government expenditures for development. Quebec Province has expressed her intention to oppose ratification of such a treaty by every means within her power. Past experience has shown that government capable of effectively sustaining her objections to power legislation. No doubt she can do this to any St. Lawrence treaty requiring an appropriation from the Canadian Government for its development. The United States Congress has also shown itself capable of blocking treaties, and there is no reason for believing that a St. Lawrence treaty requiring large appropriation will receive favorable consideration for a long time to come.

All negotiations for developing the St. Lawrence have been on the assumption that navigation and power are inseparable. There is, however, apparently no reason why Canada and the United States cannot enter into an agreement to permit power development on the river's international section without the navigation features, except to protect their future use. Such a treaty could permit construction of power dams in the river by the governments of Ontario and New York, providing such work did not interefere with present and future navigation. These works could be made subject to approval of the International Joint Commission.

A pact to permit doing this should be easily negotiated and give little cause for opposition in the two federal governments. It would not involve any ex-

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pense to either Canada or the United States and would be free of the chief cause for objections by Quebec to a power and navigation treaty. Ontario and New York would then be at liberty to execute their plans for power development on any basis they might agree upon. Furthermore, it would take the project out of politics, at least for the present, as responsibility for power development would be placed with the two governments interested in this feature of the project. The question of cost division between power and navigation would also be eliminated.

The Soulanges section of the river is now being developed by the Beauharnois Power Corporation under a similar arrangement with the Canadian Government. In this section the power development is being so constructed that present and future navigation on the river is protected. In addition, the fourteen-mile canal for power development is being built to meet navigation requirements and will be given to the Canadian Government without cost.

If a public utility company is willing to develop the power resources of the St. Lawrence in such a way that navigation is protected, state and provincial governments should be willing to proceed under a similar arrangement. New York Power Authority is apparently anxiously waiting an opportunity to develop power on the St. Lawrence. Then, why not consider the power possibilities separately, even if construction of a deep waterway has to wait, which it must do in any event? Power first and deep-water navigation after is better than indefinitely delaying both.

Retrench With Discrimination

In the drive to force further economies in Government operation as applied to the various bureaus at Washington, there is grave danger that certain activities which are rendering a genuine service to industry may be curtailed to the point of becoming ineffective.

The Bureau of Foreign and Domestic Commerce of the Department of Commerce, for instance, has built up a statistical and informational service during the past ten years that has brought handsome returns to industry, very many times the cost of operating that department which amounts to only about one-tenth of one per cent of the total Government budget.

Now, more than any other time, industries are in need of assistance such as this department is in a position to render, and any curtailment should be carefully considered lest it do more harm than good.

Economy in Government operation is laudable but it needs to be applied with discrimination.

Better Furnaces For Mid-West Coals

Boiler units combining high capacity per dollar invested, efficiency of combustion and heat transfer, ease of operation, low maintenance costs, and the ability to maintain these advantages when cheap fuels are burned, are the aim of every designer. The cheap-fuel factor is now receiving particular attention, with results that are highly gratifying. An outstanding accomplishment in this field is the recent application of refractory-coated tubes to slag-tap furnaces burning low-grade Illinois coal.

As pointed out in the leading article of this issue, there has been an insistent demand from utilities in the Chcago district for pulverized-coal furnaces that would handle such fuels without excessive trouble from tube slagging. Success has attended the use of a slag screen whose tubes are coated with refractory held in place by numerous projections. At normal ratings this screen presents a sticky surface which traps much of the dust and returns it in molten form to the slag pool.

Greatly extending the usefulness of low-grade coals, high in ash of low fusion temperature, this development is an important contribution to the economical generation of steam and power in great industrial areas of the Middle West and elsewhere.

* * *

A sizable group of senators and representatives of both parties has gone on record as intent upon making power an issue in the coming campaign. To this end the leading candidates have been polled as to their views on public ownership, regulation, mergers and rates. While this subject will provide abundant material for political oratory, it is insignificant compared to many of the major issues. Apparently some of our legislators are quite willing that the pet hobbies of certain of their fellow members shall serve to divert attention from commitments on other questions that might prove embarrassing.

* * *

At the recent conference in Cleveland on air conditioning, one of the speakers cited the results of a survey of twenty-four American cities for the years 1924-1927, which showed Boston to be the cleanest city with San Francisco ranking second. A similar survey in 1929 showed Boston still holding first place but pressed hard by other cities that had made marked improvements. New York had advanced from tenth to seventh place during this period. In view of present activities in the prevention of air pollution, a current survey would be illuminating. Why not enlist civic pride to foster competition between cities in this most important work?

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Stud Tubes

Solve Furnace Problems With Slagging Coal

Experimentation in plants of Chicago district leads to development of slag screens in which tubes are studded with pins and coated with refractory. Screen greatly reduces slagging of main boiler tubes

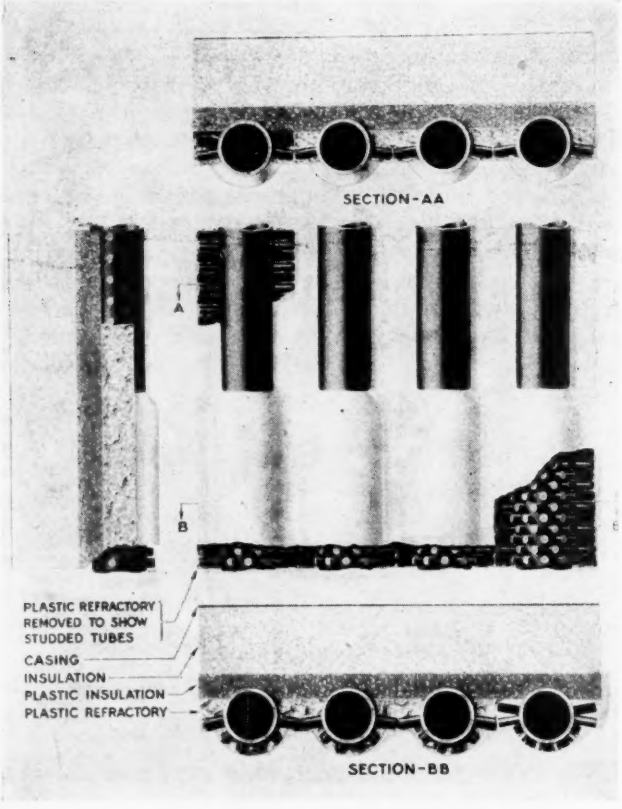


Fig. 1—Detail view of the arrangement of stud tubes for a furnace wall

The tubes in the lower portion are completely coated for zones receiving severe punishment. The upper part showing tubes partially exposed is for zones where higher heat absorption is desirable.

IN 1926 Sargent & Lundy, Inc., had undertaken to lay out a new station in the Chicago district—a station of much greater capacity than any other built up to that time—and at the same time it was required to burn a grade of Illinois coal containing a high percentage of ash, sulphur and pyrites.

These engineers had accumulated considerable data on burning this fuel on chain-grate stokers, but their experience in laying out a pulverized-coal station for Columbia Power Company at Cincinnati prompted them to investigate this subject further and quite thoroughly. They felt it would be necessary to make a trial installation at an existing station before they could be justified in laying out a new station of the proposed magnitude for pulverized coal firing of Illinois coal.

Consequently Boiler No. 22 was installed at Calumet station of the Commonwealth Edison Company. This installation, as shown in Fig. 2, has been described in some detail before, but certain features of the boiler unit are worth mentioning again, such as the boiler itself, which was of a new type and had, among other features, a steaming economizer. One of the prime innovations in design was the pulverized-coal-fired furnace equipped with a new design of burner which was later known as the Calumet burner. The furnace had completely water-cooled walls, covered by Bailey blocks and, for ash removal, a hopper bottom of the same construction.

This unit was thoroughly tested using Illinois coals and the operation was so satisfactory that five boiler units, as shown in Fig. 3, were ordered for the new and larger installation at State Line station of the Chicago District Electric Generating Corporation. The new boilers were designed on practically the same basis as the successful trial unit, but with twice the capacity of the Calumet boiler.

Later a sixth boiler was purchased and installed at State Line. The new unit was of the same general construction as the other five, but instead of having a hopper-bottom furnace it was equipped with a slag-tap furnace which was being developed elsewhere at that time and which appeared to hold excellent possibilities for burning Illinois coal.

These installations have been successful, but the problem of burning Illinois coal was so important to

Fig. 3—Section of the first five boilers installed at State Line, following the successful experiments at Calumet

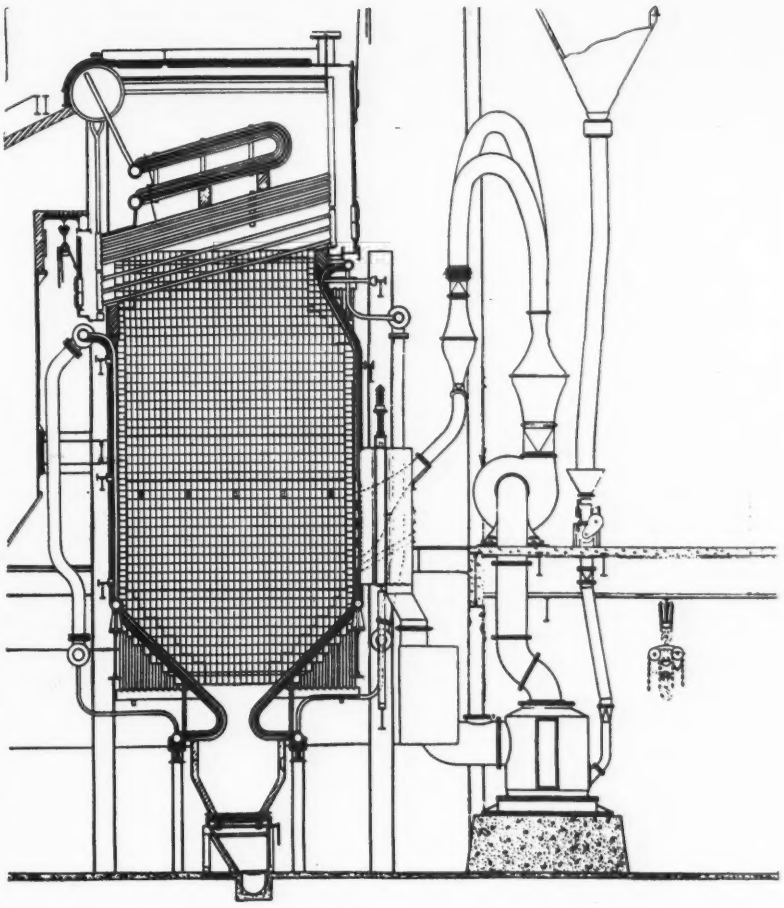
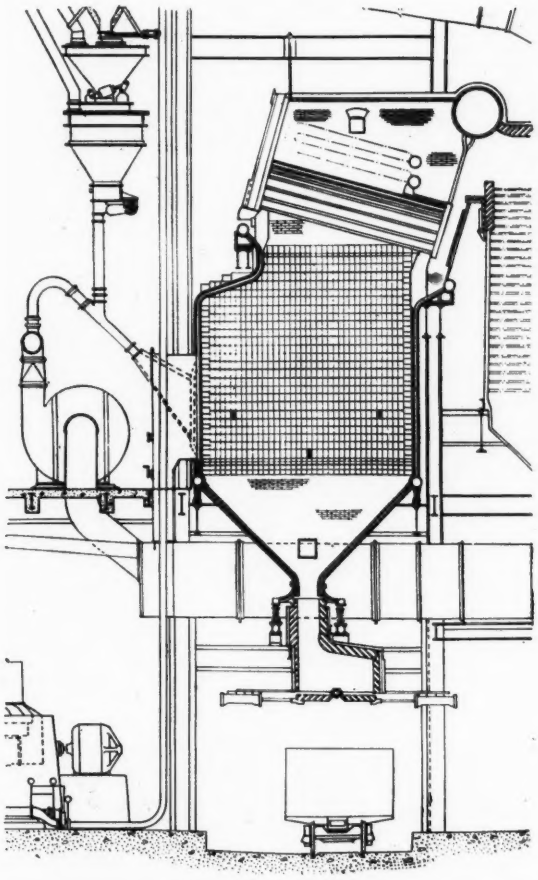


Fig. 2—Section of the pulverized-coal fired boiler No. 22 at Calumet station—forerunner of the State Line station



power plant owners in the district that no stone was left unturned in the investigation of every phase of the use of this fuel for more economic results.

The Chicago District Electric Generating Corporation has a very broad policy in planning for the future extensions to its State Line station. The company therefore decided to make further experiments in connection with the problem of slagging boiler tubes, incident to operation at high ratings and aggravated in this case by the high percentage of low fusion temperature ash, even though very wide tube spacing had been allowed and special arrangements had been made for soot blowing and lancing.

A modified furnace was designed to minimize the slagging of boiler tubes and, if possible, to recover a larger percentage of ash in the furnace, thus minimizing the dust problem throughout the boiler heating surface and reducing the quantity of ash leaving the stack. Furthermore, certain features of the slag-tap furnace had given some trouble on boiler No. 6 due to the large percentage of iron pyrites in the coal, resulting in the accumulation of metallic iron and iron sulphide in the furnace. After a thorough study of the matter it was decided by all of the engineers concerned to rebuild the furnace of boiler No. 5 entirely. Details of the reconstructed furnace are shown in Fig. 4.

A dust and slag collecting screen was placed in the upper part of the furnace, but below the bottom row of boiler tubes. This screen consisted of a number of water-cooling tubes grouped to obtain a baffling effect. Some of the tubes had extensions welded to them so as to retain a refractory coating. This coating somewhat reduced the rate of heat absorption and made it possible to collect more readily ash that came into contact with the tubes.

Dust and Slag Screen Modified

After some tests with this design a further change was made, the screen being constructed as shown in Fig. 5. The tubes of the screen were of $2\frac{1}{8}$ in. diameter to go between $3\frac{1}{4}$-in. wall tubes located on 6-in. centers. Within the furnace each tube had a series of closely spaced studs welded to it and covered with refractory to an outside diameter of 5 inches.

This construction allowed the desired rate of heat transfer to be maintained, and in service the tubes presented a hot sticky surface upon which slag readily collected. The temperature of the furnace was such that at all normal ratings the slag melted and ran down into the slag pool.

The screen shielded the boiler tubes from direct radiation and the ash that did pass through the screen was

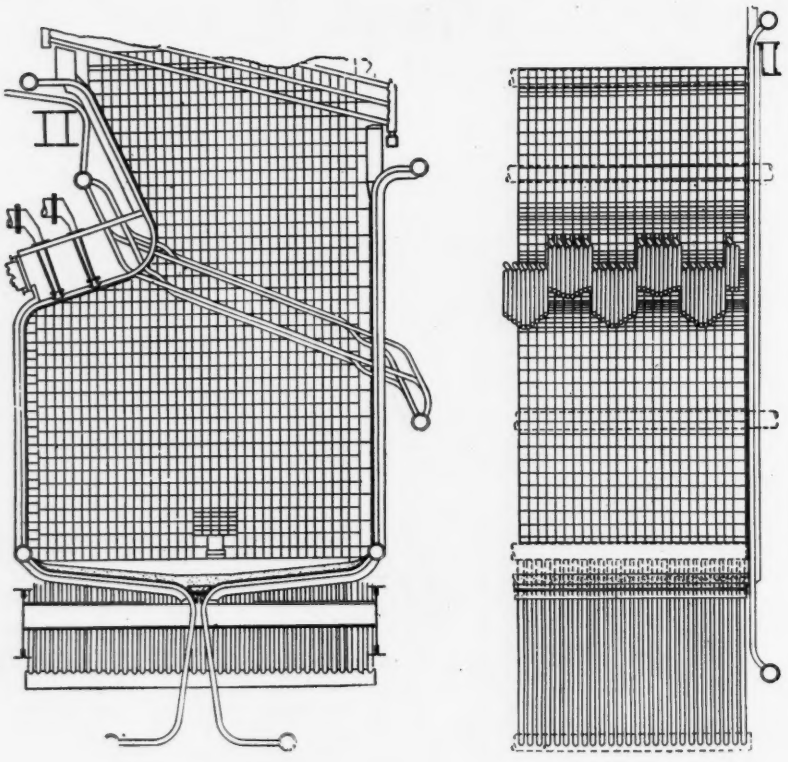


Fig. 4—Boiler No. 5 at State Line after furnace was changed to the slag-tap type with water-cooled floor and a dust screen installed below the bottom row of boiler tubes

cooler and less sticky, thus effecting a real improvement by materially reducing the slagging of the boiler tubes.

The construction of the dust screen having tubes with studs and refractory facing to intercept ash at very high temperatures propelled by high velocity gas was an outstanding achievement in furnace construction.

The heat liberation below the dust-collecting screen exceeded 50,000 B.t.u. per cubic foot and the liberation in the entire furnace up to the bottom row of boiler tubes of the boiler was 35,000 B.t.u. per cubic foot, as compared with a heat release of 30,000 B.t.u. per cubic foot of furnace volume in the Calumet boiler.

The water-wall tubes in the side walls and floors of State Line furnaces are covered with Bailey blocks in the usual manner, part of them being smooth iron, others rough block, and some refractory-faced, located in each case according to the zone of the furnace .

While the block-covered tubes in the furnace have been very satisfactory, further interest on the part of Sargent & Lundy, Inc., the operating department of the Chicago District Electric Generating Company, and the Babcock & Wilcox Company, manufacturers of the boilers and furnaces, led to the decision to try a construction of wall with tubes similar to those used in the dust screen experiments.

The section of new wall installed was composed of $3\frac{1}{4}$-in. tubes on 6-in. centers without blocks but with the lower portion of the tubes studded and coated with refractory material. The upper parts of the tubes were bare in front but had studs extending from each tube toward the other, the space between being filled with refractory, making a wall construction which could be modified according to the requirements of the furnace and the kind of fuel to be burned. It is believed that

Fig. 5—Form of dust screen finally used in the furnace of boiler No. 5 at State Line

The dust screen tubes were studded and covered with refractory material except at the ends, where the tubes were bare to permit expansion.

this design is suitable for still higher ratings and if necessary the utilization of even lower grades of fuel than those used up to this time.

Figs. 6 and 7 are photographs showing a part of the downtake wall of boiler No. 6, in which the tubes of this construction were tried out. This boiler has been in practically continuous service since the new section of wall was installed in the early part of 1931. Low-grade Illinois coals were used and the refractory and ash coating in the furnace zone subjected to the most severe service was quickly reduced to an equilibrium point from which no further erosion took place.

Fig. 1 shows a more detailed arrangement of stud tubes for a furnace wall. The lower portion is completely coated for zones receiving severe punishment. The upper portion, showing tubes partly exposed, may be used in cooler parts of the furnace so that more rapid heat absorption can take place without interfering with the efficiency of the furnace.

In addition to the interest possessed by this furnace wall because of its association with a notable evolution in furnace design, it is apparent that the stud tube wall has some unusual features of construction. These features suggest many uses for the new wall. In this connection the manufacturers point to the fact that blocks, clamped to tubes, will remain the most desirable construction for many places. In fact the use of block-covered tubes will probably be not merely desirable but necessary in some cases as for example, on and around the bottom of slag-top furnaces.

On the other hand, the new stud tubes, with their lower investment cost, appear to hold interesting possibilities, especially for pulverized-coal-fired furnaces. They offer the possibility of use to make up a new type of wall structure with the same fundamental characteristics as the block-covered wall but in a different form to supplement present constructions. Thus a combination of the two types can be used to meet a much wider range of conditions.

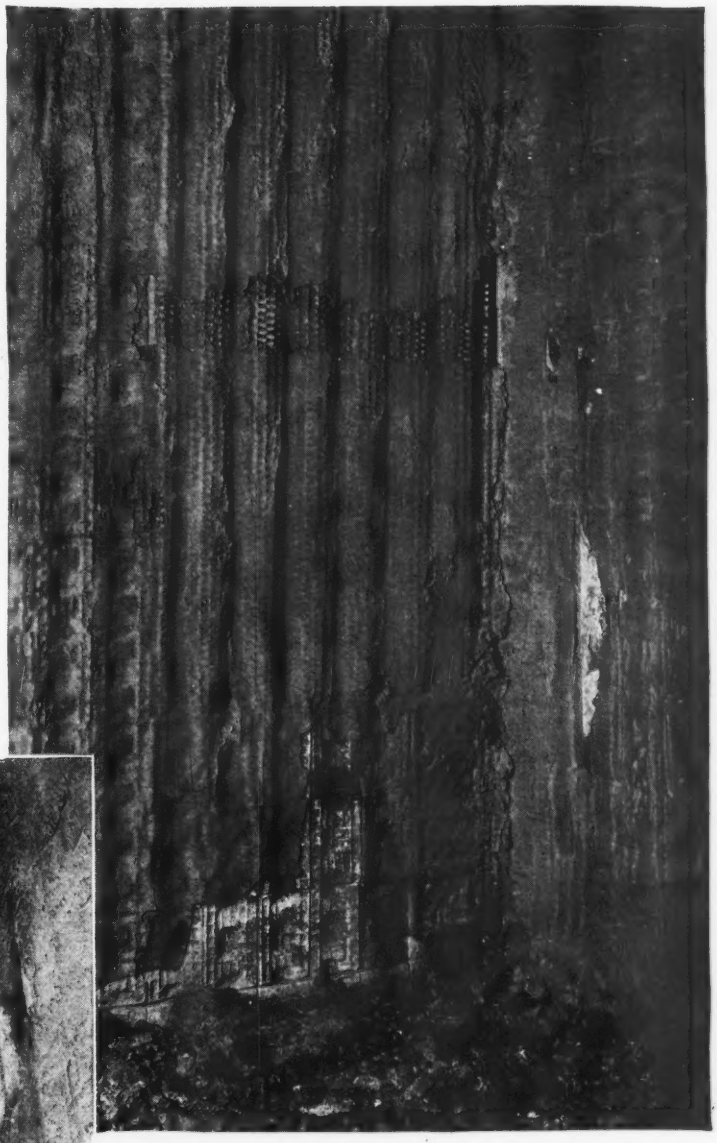


Fig. 6—Lower portion of the new furnace wall installed as a part of the downtake wall in boiler No. 6 at State Line, after the dust screen arrangement had proved so successful

Fig. 7 (left)—Upper part of the new furnace wall shown in Fig. 6

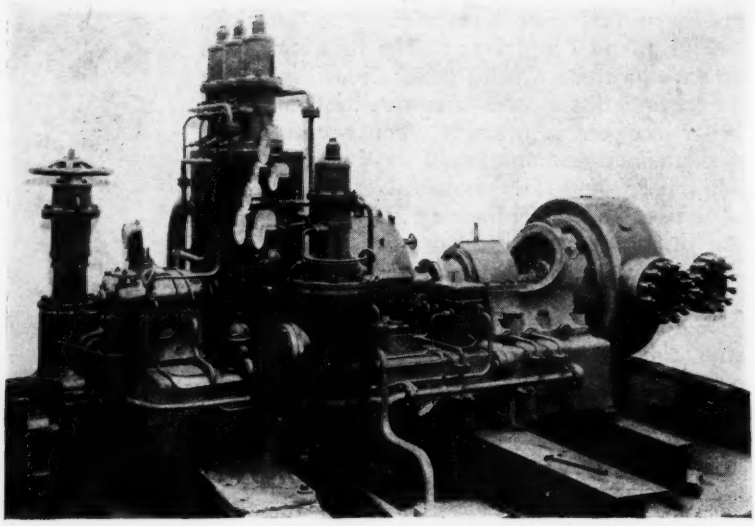


Fig. 1—Shop view of turbine-driven steam circulating pump with oil-seal bearing for 88,000 lb. per hour Loeffler boiler

By BRUNO BELOHLAVEK
Witkowitz

Steam Circulating Pump of the Loeffler Boiler

Much interest has been expressed in this country as to the design and operating experience with steam circulating pumps of Loeffler boilers. This article was prepared at the request of "Power" and has been translated by Arthur J. Herschmann, M. E., the United States representative of the Witkowitz Steel Works. It tells of the development work which has been done in connection with the piston-type pumps and the centrifugal pumps for the Loeffler system of steam circulation and operating experience is related. Calculations of the power required for the forced circulation is appended

THE circulating pump is basic with the Loeffler boiler, as can be readily seen by reference to Fig. 3. The energy required to overcome the resistance to the flow of the steam must be supplied by the circulating pump. This amounts to about 2 per cent of the energy of the boiler and assures the efficient circulation of the steam. The forced circulation also keeps the superheater tubes from overheating and the wall temperature of these tubes never exceeds about 1076 deg. F. despite the high temperature of the circulating steam and the high heat transmission through the walls. One may thus obtain, at any load on the boiler, with safety of operation, a uniformly constant total steam temperature of 932 deg. F. The higher superheat represents a gain in thermal efficiency that exceeds the cost of the steam pumping. It will be shown later on that a considerable part of the energy required by the circulating pump is returned to the system in one form on another.

The first Loeffler boilers, the 20,000-lb. per hour unit which has been in service at the Vienna Locomotive Works since 1925 and the 33,000 lb. per hour unit, which has been in use since 1927 at the Caroline Mines in Czechoslovakia, were equipped with reciprocating pumps. Both installations have obtained good results with these piston pumps in sustained service. The Loeffler locomotive, completed during the summer of 1930 by L. Schwartzkopf, Berlin, also uses the piston type of circulating pump. Later installations have been equipped with centrifugal pumps because the boilers were of larger size and displacement pumps would have been unduly large. For boilers furnishing 30,000 lb. of steam per hour and less, the piston pump would be definitely preferred. Constructional details of the circulating pumps at the first two plants mentioned have been reported in engineering papers, notably in the article *"The High Pressure Age"* by Professor Loeffler, which appeared in Z.V.D.I. in 1928. Therefore only the high spots of additional experience which has been gained during the last four years will be touched upon here.

To balance the moving parts and to give uniform steam flow the three-cylinder type would be retained in the future. The coupling together of the circulating pump and the boiler feed pump as was done in these earlier plants would not be continued particularly for larger units, since the circulating pump can be speeded up much more than can the boiler-feed pump.

There are also operating reasons which make separation preferable. Trouble with the stuffing boxes no longer exists. Only split ring metallic packing would be used in the future as illustrated in Fig. 4. Soft packing was found to be short lived. For the valve gear both piston valves and automatic disc valves have proved

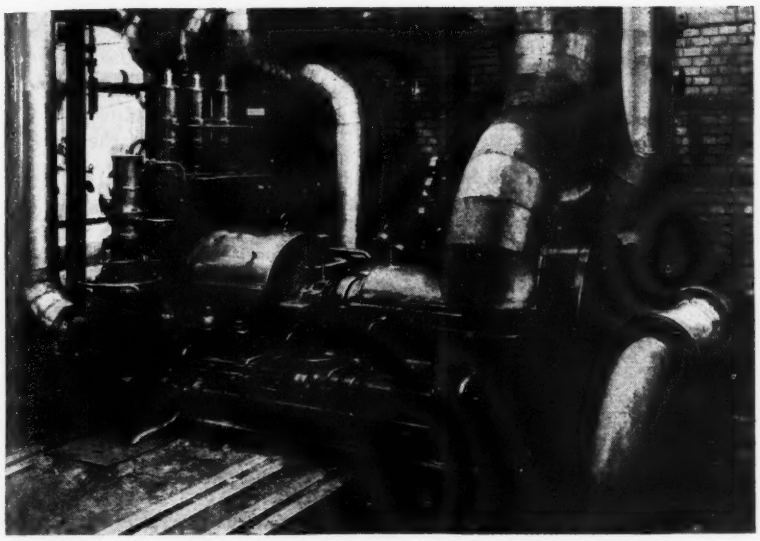


Fig. 2 — Turbine-driven steam circulating pump with labyrinth packing for 88,000 lb per hour Loeffler boiler

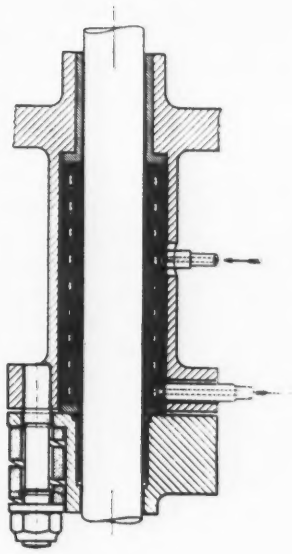


Fig. 4 — Split-ring metallic packing

satisfactory. Preference is now given to the latter since they are cheaper and simpler. To resist shock at a temperature of about 572 deg. F. these valves must be strong, light and of suitable material. (See Fig. 5).

Difficulty was had chiefly with the piston rings. A number of variously shaped piston rings were tested before it was found that high and narrow rings made of a special cast iron produced in an oil-fired furnace gave best results. It was found, and experience gained elsewhere has corroborated this, that there was very low pressure under the sliding surface of these rings which caused them to be pressed excessively against the cylinder wall. The friction was thereby unduly increased and rapid wear and breaking of rings was feared. Equalizing holes were drilled to relieve the rings without appreciable easing of that condition. To drive the displacement type circulating pump an electric motor which permits wide variation of speed may be used or preferably a steam engine. In the latter case, the steam cylinder would be superimposed upon the pump cylinder. The piston-type steam circulating pump of the Loeffler Schwartzkopf locomotive is so designed.

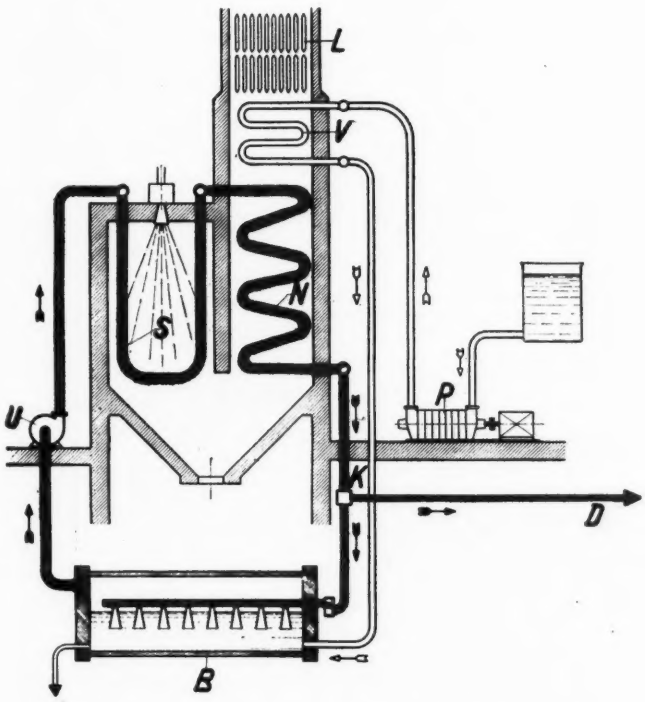


Fig. 3—Diagram of Loeffler system of steam generation

The circulating pump *U* takes saturated steam at 1,900 lb. from the vaporizing drum *B* and boosts it through the series superheater *S* and *N* and causes the return of the major portion of the superheated steam into the vaporizing drum, while the remainder of the superheated steam *D* goes to the prime mover. *P* is the feed pump, *L* the air preheater, and *V* the economizer.

Development of the Centrifugal Type Pump

The centrifugal type would be used for boilers supplying 30,000 lb. of steam per hour and over. The superior reliability of this type has been proven in sustained operation of over a year and a half. The first design of the centrifugal type was made by the late Professor Loeffler. Credit is due Escher, Wyss & Co. of Switzerland, which developed and installed the first pump of this type for the Loeffler boiler at the Witkowitz Mines.

No difficulty was anticipated as to the required compression of saturated steam from 1,900 lb. to say 1,945 or 1,975 lb., but the sealing of the stuffing box required much study. With a view to adaptation for the two later Loeffler boilers of 110,000 lb. of steam per hour for the power plant of the Caroline Mine at Witkowitz, three possibilities were investigated as regards the sealing:

1. Soft packing similar to that of centrifugal pumps for water.
2. Sealing by means of a liquid.
3. Labyrinth sealing.

Superficial tests sufficed to eliminate soft packing. The friction in such packing of 5,000 to 8,000 r.p.m. was found to be excessive and the unreliability of soft packing which was experienced with the piston type of pumps was known. The third possibility was not given much consideration at first as the leakage losses were considered to average 3 per cent of the circulated steam and therefore about 10 per cent of the line steam. Such loss could not be considered. For that reason the second plan was developed. Fig. 6 shows the arrangement of the oil duct stuffing box in which an oil of high viscosity serves as the sealing medium.

The bearing of the pump acts also as stuffing box. The white metal with which the bearing is lined has a

clearance of only 0.002 in. for the diameter. The sealing oil was introduced into that annular clearance space of the bearing at a pressure which exceeded the pressure within the pump housing by 30 lb. The sealing oil tries to escape and in filling this clearance prevents the escape of steam. The oil-sealing stuffing box therefore acts somewhat similar to a labyrinth stuffing box in which however oil escapes instead of the steam. Owing to the high viscosity of the oil only a relatively small quantity flows through the clearance space and steam losses are entirely avoided. Therefore best results were expected from this arrangement.

The circulating steam pump of the 110,000-lb. boiler at the Caroline Mines has a single impeller wheel of

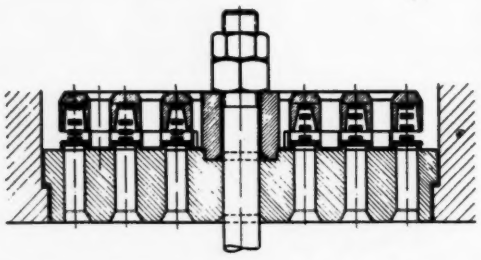


Fig. 5—Type of disc valves that has proved satisfactory

12 in. diameter which is mounted on the end of the pump shaft as is the propeller on the shaft of a ship. The pump shaft has a diameter of 2.125 in. and therefore a median circumference for clearing of 6.751 in.; with a clearance of 0.002 in. on the diameter the area through which oil leakage occurs is 0.007 sq.in. It would be difficult to calculate theoretically in advance how much oil is due to escape through such a space since that quantity depends not only on the pressure differences and the clearance amount but also upon the speed of the shaft and the viscosity of the oil. The viscosity in turn varies with the temperature within the clearance space.

With due regard to an expected widening of the clearance space through wear, the oil feed pump was built for an hourly capacity of about 1,000 lb. of oil with a discharge pressure of 2,250 lb. per sq.in. Such a pump would serve the bearing with an ample supply of oil under all circumstances. The oil feed pump was of the gear wheel type built with a double housing and electrically driven by a 20-hp. motor. Since the viscosity of the oil fluctuates with the temperature, and the oil consumption increases with decrease in viscosity. It was found necessary to provide ample cooling for the pump shaft and also for the stuffing box housing so as to preclude excessive heating of the bearing due to heat which is conducted from the pump housing. Provision was made to cool the oil.

Special provision had also to be made to cool the pump shaft and the stuffing box housing. This cooling was effected by high-pressure condensate. It was kept in circulation through a second cooling cycle with constant recooling, by means of a small impeller wheel mounted upon the pump shaft. The force of the impeller action was augmented by thermosyphon action. The oil which the oil feed pump P (Fig. 6) delivers at 2,250 lb. pressure is throttled by the excess pressure regulator R to 1,930 lb. The oil which enters the annular passage has therefore at all times a pressure which exceeds by approximately 30 lb. that which obtains within the circulating pump housing. The oil will therefore flow under a pressure of 1,915 lb. to the outside through the pump bearing and only a small portion of about 50 to 60 lb. per hour escapes through the advance leakage ring space toward the cooling chamber of the stuffing box under the pressure difference of approximately 30 lb. The latter portion of the sealing oil was constantly withdrawn by a needle valve V together with a little water, and after passing through a settling chamber, returned to the oil circulation system together with the main oil supply of the latter. The oil which leaks through the main clearance channel amounts to about 80 gallons per hour. Oil of about 7.8 deg. Engler viscosity was used at a temperature of 86 deg. F. The circulating pump which had this method of oil sealing was in use between July 1930 and February 1931 and gave good results.

Fig. 7 shows the steam circulating pump of boiler No. 2 at the Caroline Mines fitted with an oil-sealed stuffing box. Later on it was reconstructed in view of good experience which had been gained in the meantime with the "labyrinth" type stuffing box.

On the boiler No. 3 at the Caroline Mines a circulating pump fitted with labyrinth stuffing box was tried. It was also constructed by Messrs. Escher, Wyss & Company and is considered to have merit. Fig. 8 shows its construction to be in principle like that of the pump which had the oil-sealed stuffing box. Here again the overhanging impeller is within a rugged housing of cast steel. There being no longer a bearing close to the wheel, another bearing having had to be provided some-

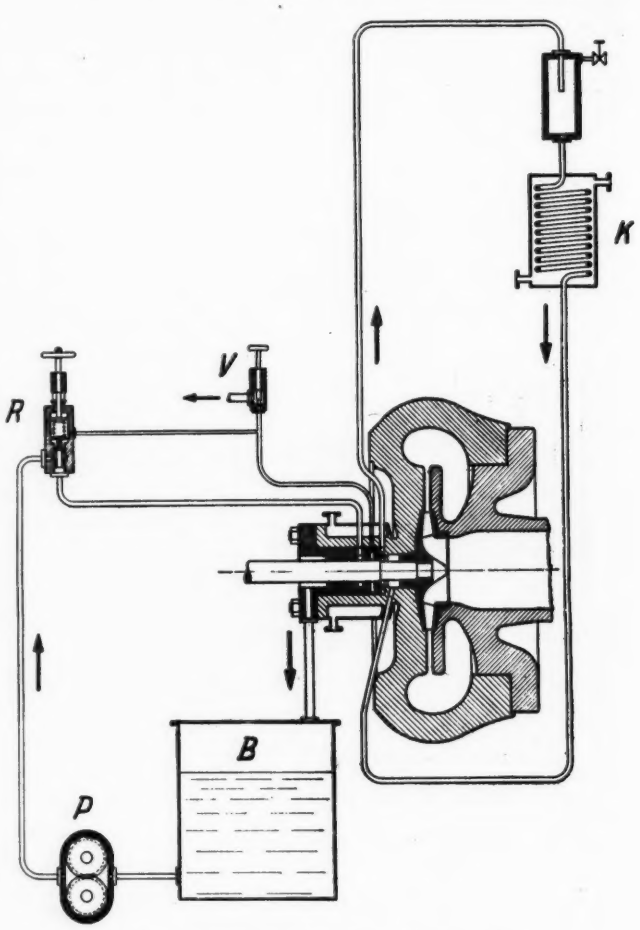


Fig. 6—Section of oil-duct stuffing box
B is the oil tank; *P* the high-pressure oil pump; *R* the excess-pressure regulator; *V* the needle valve; and *K* the cooler.

what further away from the wheel towards the outside. That made the overhanging shaft end longer and it had therefore to be made larger to withstand its critical speed. Within the stuffing box itself the shaft end is stepped down about five times, each step forming a cylindrical portion showing from six to eight individual labyrinth elements. By this tapering the mass was reduced as much as possible at the shaft end. Also the areas of the labyrinths were likewise reduced and the axial thrust was diminished, which is of special importance. This construction resulted in providing a large number of labyrinth teeth both axially and radially. As a result this pump was found to remain beneath its critical speed in spite of running at about 8,000 r.p.m.

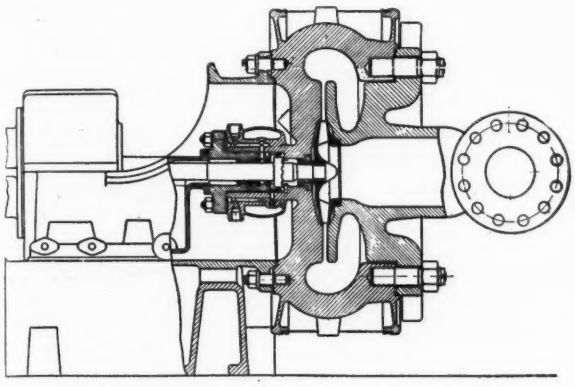


Fig. 7—Turbine-driven steam circulating pump with oil-sealed stuffing box

Escher, Wyss & Company guaranteed that the stuffing box would not show a steam loss in excess of 1,325 lb. per hour. Expressed in another way the guarantee was that the steam loss would not exceed one-half of one per cent of the circulated steam. But even that amount of steam does not all escape wastefully since it is returned with a pressure of 180 lb. for further work of expansion in the turbine which drives the circulating pump. Even the small portion of the sealing steam which expands in the low-pressure end of the stuffing box from 180 lb. to 18 lb. is piped out of the stuffing box into a condensing vessel where it contributes to the warming of the feed water for the boiler.

It can be seen from Fig. 9 that the allocation of the circulating pump within the heat flow diagram of the power plant was very carefully made. The stuffing box, apart from slight increase of entropy causes practically no loss, as all heat which is conveyed to the stuffing box is being engaged in useful work. The construction was improved by utilizing a recent invention made at Witkowitz whereby superheated steam of 752 deg. F. is bled into the stuffing box from the radiation superheater of the boiler. Such steam protects the stuffing box whereas it would be eroded by the moisture if saturated steam were used. But this use of superheated steam shows further advantages. The volume of steam passing through the stuffing box becomes very much smaller and the steam which leaves at 180 lb. has higher value than it would have otherwise and it is better suited for use in the circulating pump turbine.

It is worthy of note that the centrifugal action of the impeller of the pump may effectively separate moisture from the steam. To effect such separation of moisture suitable ducts are provided within the pressure space along the inner circumference which catch any drops of water that may be thrown out and return them to the vaporizer drum. Only dry, saturated steam enters the superheater tubes under any circumstance. Incrustation cannot take place even when the contents of the vaporizer drum are none too clean in which condition moisture would be impregnated with scale forming impurities.

Thus far the labyrinth-type of stuffing box has been in continuous operation over six months and the results have been most satisfactory. The steam that escapes through the box at 180 lb. has been found to be but 900 lb. per hour while a maximum leakage of 1,325 lb. was the basis of the guarantee. The steam which leaked with 18 lb. pressure was only 1,790 lb. per hour.

The reliability and safety of operation of this circulating pump is based upon the design and construction of its turbine and regulating mechanism, which must be so as to maintain the speed constant once it has been established. The speed will vary only if the operator makes an adjustment following a change in the load on the boiler. The range of variable regulation must be wide so that the pump may follow the boiler on the side of load increase as well as on that of partial load. The turbines which also have been built by Escher Wyss & Company permit a speed variation from 2,000 to 8,000 r.p.m.

Let us see how much steam the booster pump has to circulate and how great is the pressure difference which the pump has to overcome at various boiler loads. If D represents the quantity of steam per hour supplied to the turbine, the pump will have to circulate an hourly quantity of steam G equal to $u \times D$ where u

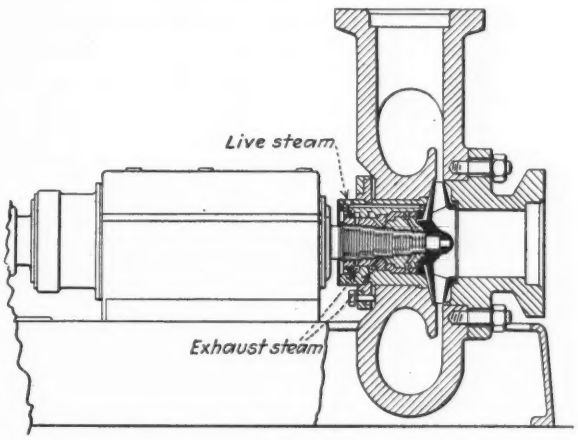


Fig. 8—Turbine-driven steam circulating pump with labyrinth stuffing box

(always greater than one) is called the circulating coefficient.

The exact value of u depends on the final condition of the steam D and is also affected by the temperature fluctuation of the feedwater that enters the vaporizing drums. If h represents the heat content of the operating steam, h^2 that of the saturated steam in the vaporizer drum, h^1 the heat content of the liquid in the drum and t the heat content of the feedwater which goes into the drum, the following equation defines the coefficient of circulation.

$$u = \frac{h^2 - t}{h - h^2} + 1$$

For operating or working steam of 1,900 lb. with total temperature of 932 deg. F. and a heat content of the feed water of $t = h^1 - 90$ B.t.u. the coefficient of circulation is found to be 2.8.

The pressure difference which the booster pump has to overcome has for its base a slight "injection resistance" which is constant at any and all boiler loads and depends otherwise on the resistance which the inner tube surfaces offer to the flow of the circulating steam, besides tube curvatures, etc. That pressure difference therefore chiefly depends upon the nature of the surfaces of the superheaters and upon the steam velocities within the superheater pipes which velocities must be so great that ample cooling of the heating surfaces is effected. For pressures in excess of 1,500 lb. in the radiation part of the superheater S a velocity of no more than 60 to 66 ft. per sec., and in the convection superheater 20 to 26 ft. per sec. is sufficient for ample cooling under such conditions and during normal load of the boiler a pressure drop of about 60 lb. will result.

It is of interest to observe the influence of the steam pressure and the load of the Loeffler boiler upon the pressure difference which the circulating pump must overcome and therefore upon the energy requirement of the pump. The formula for calculating the pressure difference, according to O. Fritsche is

$$\Delta p = \frac{12.5\,\beta \left(\frac{G}{n}\right)^2 V_m \times L}{d^5}$$

where L is the tube length in meters, V_m the median specific volume of the circulating steam in cubic meters per kilogram, G the circulated steam in kilograms per hour, n the number of heater tubes in parallel, d their inside diameter in millimeters and β the resistance coefficient which is evaluated by the formula:

$$\beta = 2.526 \times \frac{d^{0.027}}{\left(\frac{G}{n}\right)^{0.148}}$$

With decreased weight of circulated steam, and therefore with decreased boiler load, it is seen that the pressure drop decreases as does the square of the steam weight G on condition that we disregard the variability of the coefficient β.

For the energy requirement of the circulating pump

$$N_e = \frac{G \times V_s \times \Delta p \times 10{,}000}{3{,}600 \times 75 \times n}$$

Here V_s is the specific volume of the circulated saturated steam.

If we introduce in this formula the value of Δp from above, we arrive at

$$N_e = \frac{12.5\,\beta \times L \times 10{,}000}{3{,}600\,d^5 \times 75\,n \times n^2} \times G^3 \times V_s \times V_m$$

To simplify, assume β to remain constant and, as $G = u \times D$, the product of the circulation coefficient multiplied by the weight of the steam used on the line, we find the energy required for the circulating pump to be $N_e = constant\ u^3 \times D^3 \times V_m \times V_s$.

The power requirement of the pump is proportional to the cube of the weight of the steam which is withdrawn from the boiler. Since both the circulation coefficient u and the specific volumes greatly decrease with rising pressure in the boiler it is clearly shown by the formula for the required pump energy N_e that the Loeffler system is decidedly a high pressure type of steam operation. Calculations made on the basis of the formula N_e show that the pressure differential can only be held within economical limits for pressures in excess of 1,200 pounds.

The actual energy requirement of the circulating pump is 7.8 hp. hr. per ton of line steam for operation at 1,900 lb. with 932 deg. F. total temperature. The circulating pump absorbs only 2 per cent of the boiler energy at 1,900 lb. pressure, whereas it absorbs 13 per cent for a pressure of 750 lb. and the entire energy of the boiler if the pressure were but 300 lb. Which proves that the Loeffler system has no value for the generation of low-pressure steam.

The energy used for steam circulating is used almost entirely to overcome the frictional resistance of the superheater tubes and it is therefore converted into heat of friction which in turn raises the temperature of the steam. Only the friction of the bearings of the circulating pump and the losses due to heat radiation of the pump and its pipe connections are real energy losses; the balance of the energy required to operate the circulating pump goes into useful heat of the steam. The bearing friction of the pump together with its losses due to radiation should not exceed 5 per cent of the energy applied at the circulating pump shaft.

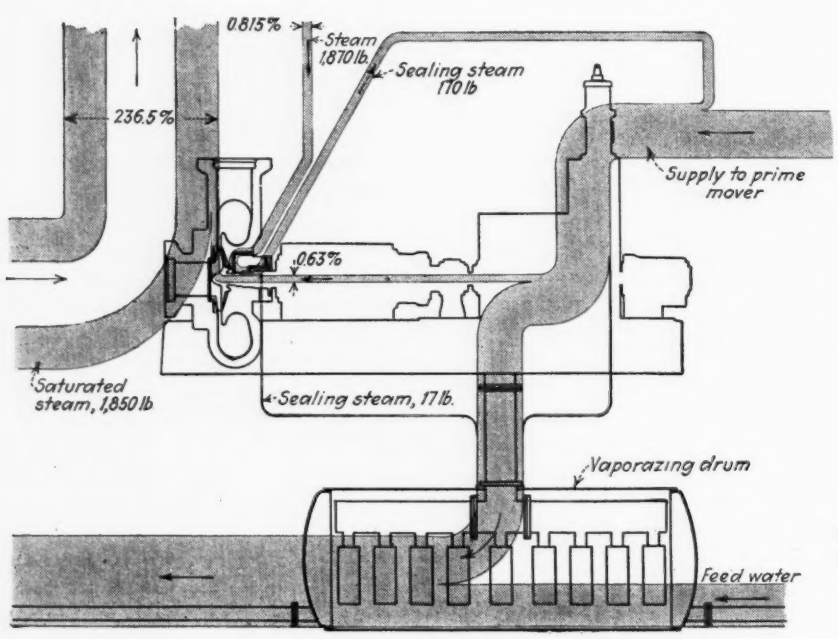


Fig. 9—Flow diagram with Loeffler system, showing steam distribution

Refrigerating Plant Analysis By Temperature Elevation Diagram

By VICTOR J. AZBE
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THE IDEAL ice plant using a cooling tower would have a condenser pressure corresponding to the wet-bulb temperature, while its suction pressure would correspond to 32 deg. F., the freezing point of water. Although this ideal for many reasons is not attainable, the approach to it can be used as a measure of the excellency of the plant. If, then, the whole is pictured in the form of a graph, not only the degree of inefficiency, but actual points where the losses occur and their approximate magnitude, are revealed at a glance.

At present the refrigerating engineer deals with pressures and temperatures, pressures on the ammonia side and temperatures on the water and brine side. Ammonia pressures, which influence power requirements, depend, in turn, to a governing extent, upon condensing system temperatures, but the relationship is hard to visualize unless the two systems of measurement are brought to a common basis. The common basis is either pressure for both or temperature for both, and it is evident that temperature is the logical common ground. It would be far better for the engineer if his pressure gages were calibrated in saturation temperatures rather than pounds per square inch. He then could immediately tie the entire plant together without any reference to tables or making calculations. He would know what his "approaches" are, and "approaches" are what determine refrigerating plant efficiency. For example, to what extent does condensing temperature approach the outdoor wet-bulb temperature? How closely does the temperature of saturation of suction gas approach the freezing water temperature or the brine temperature? With these and a dozen other "approach" figures the comparative efficiency of the plant can be determined.

Throughout this article, for simplicity's sake, temperatures mean the temperature of saturation. This temperature, when there is superheat, cannot, of course, be obtained with a thermometer; in fact, as far as this analysis is concerned, nowhere on the ammonia side should the thermometer come into play except where it is directly submerged in the liquid. The saturation temperatures always are to be determined either from accurate pressure gages or by scaling of indicator diagrams. The thermometers are used only on the brine and water sides.

Using pressures makes it difficult to estimate magnitudes, as ten pounds difference up or down in condenser pressure represents ever so much less in power than ten pounds up or down in suction pressure. Ten pounds reduction in condenser pressure, as well as two pounds increase of suction pressure, means a saving of 5 per cent in compressor power. This, however, is an approximate figure; the exact amount will depend on the exact elevations of the condensing and the suction pressures.

If the pressure-power relationship is plotted the line is a curve, but with temperature-power almost a straight line is obtained. Fig. 1 presents comparative compressor power plotted against various suction temperatures for various saturation temperature ranges of compression. For example, on this chart if compression is from 10 deg. F. through a range of 80 deg. or to 90 deg., the brake-horsepower required at the ammonia compressor per ton of refrigeration is 1.25.

An ice plant consists of a great many units that may perform well or poorly. The plant cannot be efficient unless each integral member is efficient. Leaving out such units as the boiler, stoker, feed-water heater, auxiliaries, etc., and confining the analysis to the refrigerating side proper, there is to be considered the water-cooling system external of ice cans, water-freezing system, ammonia compression system, ammonia piping system, ammonia condensing system and cooling tower system.

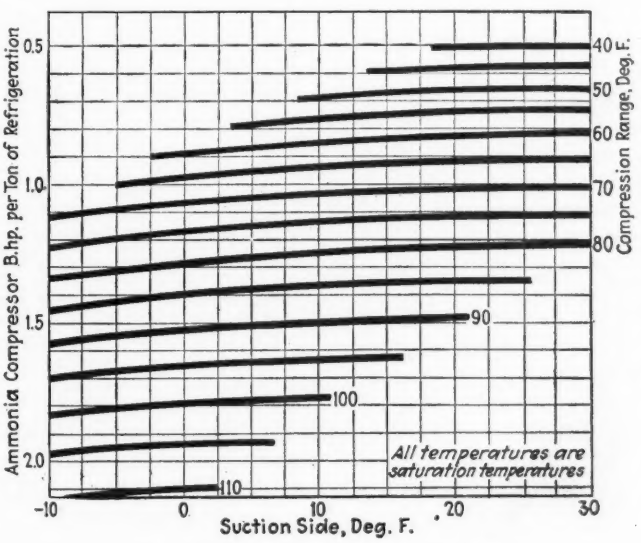


Fig. 1—Power required for ammonia compression per ton of refrigeration

It is this combination that will determine the compressor power necessary and it is the intention to introduce a diagram on which it is possible to picture performance so that the degree of approach to the possible can be immediately noted.

This diagram, Fig. 2, is divided vertically into temperatures and horizontally into the systems enumerated in the previous paragraph.

To construct the diagram, first indicate in the section *Water Freezing* the freezing temperature of pure water 32 deg. F. by means of a line. Then draw the

line for brine temperature, which, in this case, is 15 deg. F. Underneath this is indicated the temperatures of saturated ammonia in the tank coils, obtained by means of a thermometer or determined from a pressure gage on the header.

These three points by themselves reveal considerable information. Had the can surface been greater the brine temperature level could have been higher, which, in turn, would permit an increase in the temperature of the ammonia in the tank coils.

An increase in the ammonia evaporating surface would also have permitted an increase in the temperature of ammonia in the tank coils. Both temperatures could have been raised if the brine were circulated more effectively. Although it is well understood that such changes improve the performance of the plant, nevertheless until the degree of betterment is known the information fails to make an impression.

Considering next the *Ammonia Compression System,* the pressure and corresponding saturated temperature of ammonia during the suction stroke of the compressor is determined from compressor indicator diagrams and plotted. As shown in Fig. 2, it is 9 deg. F., while in the tank coils the temperature was 11 deg. F. By applying the indicator to the suction header it is found that this loss is in the suction valves, due to wire-drawing, with no loss in the piping leading from the tank coils to the suction header at the compressor.

Nine degrees is the lowest temperature level, and from this the ammonia gas must be elevated to the conditions at the compression side of the cylinder. By scaling the same indicator diagram from which the 9-deg. low side was determined, it is found that the high side has a pressure corresponding to 98½ deg. and the compression is through a range of 89½ deg.

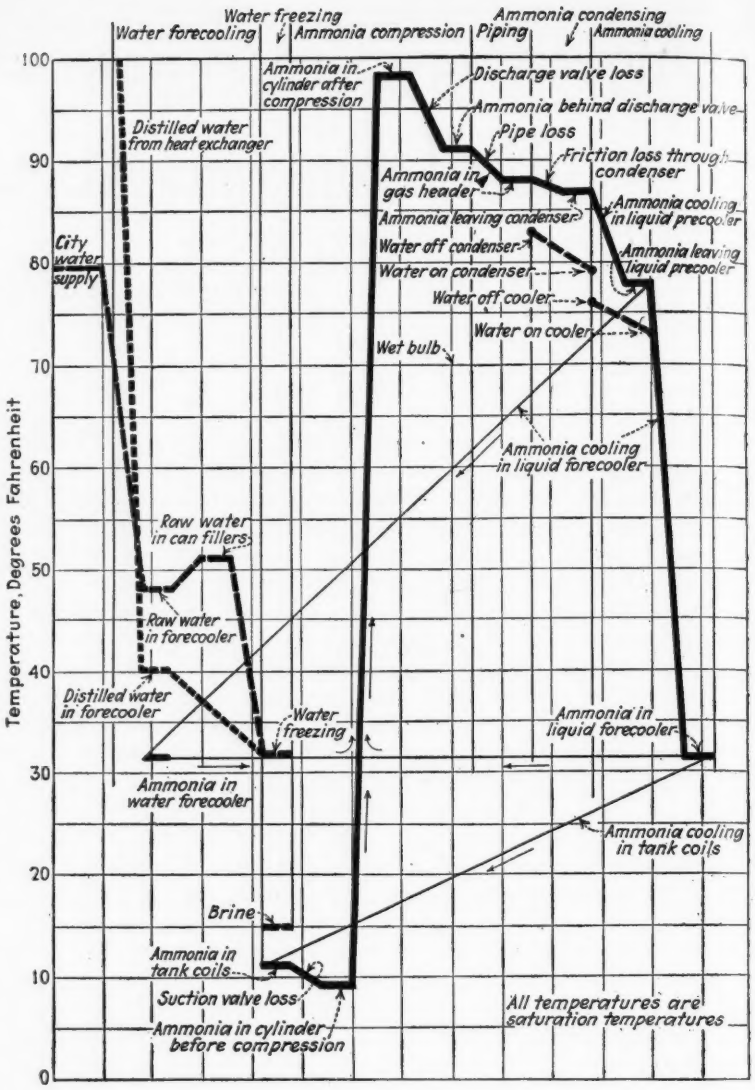


Fig. 2—Chart for analyzing performance of a refrigerating plant

Reduction in the temperature of the cycle means a saving in power. If there had been no suction valve loss compression would have been through only 87½ deg. and the power saved would have been $\frac{89.5 - 87.5}{89.5} = 2.2$ per cent, approximately. The benefit derived by increasing the suction temperature may be calculated in the same way.

As temperature elevations, while approximately indicating power requirements, are not exactly proportional to power, Fig. 1 should be used to find the exact power requirements.

By applying the indicator to successive points of the ammonia piping between the compressor and the condenser a considerable pressure loss through the discharge valves is discovered, equivalent to 7½ deg. in temperature. Then there is a loss of 3 deg. due to friction in the piping leading to the condenser. It is even found that there is a pressure loss between inlet and outlet of the condenser.

The performance of the condensing system in total is affected by the outdoor wet-bulb temperature, by the cooling tower and its ability to approach the wet-bulb and by the ability of the condenser to approach the water temperatures created by evaporation in the cooling water. In this case the wet-bulb temperature is 70 deg. F. and water going to the condenser is 79.5 deg. F. This would seem to be a poor approach to the wet-bulb temperature and either the atmospheric cooling tower was very inefficient or the wind was extremely sluggish. Good performance requires the water temperature to be within about 3 deg. of the wet-bulb. This would have dropped all discharge side temperatures and would have saved considerable power.

Continuing with the ammonia condensing system, it is found that the water temperature rise in passing through the condenser was only 4½ deg., indicating a large amount of water being pumped per ton of refrigeration. This, if done with an efficient pump against a minimum pumping head, is good practice, as the lower the temperature of water leaving the condenser the lower will be the condenser pressure. In this case the approach of ammonia temperature corresponding to its pressure to the water temperature at the outlet is 4½ deg. and on the inlet side of the condenser, 7½ deg. There are condensers capable of better performance, but most of them are decidedly poorer.

This about completes the ammonia condensing system, and from the few lines indicating the condition on the graph, the engineer can picture in his mind rather clearly, not only where improvement is possible but also what

effect a closer approach to the governing wet-bulb would have on the plant as a whole. At a glance, for example, it is evident that the friction drop through the condenser was insignificant compared to friction drop through the discharge valves of the compressor.

The work of elevating the ammonia through 89½ per cent may be divided as follows:

	Deg. F.	Per Cent
Natural elevation of wet bulb above freezing point of water	38	42.4
Friction of gas in compressor condenser and piping system..	13.5	15.1
Temperature difference necessary for heat transfer between cans and brine	17	19
Temperature difference necessary for heat transfer between brine and ammonia	4	4.5
Temperature difference necessary for heat transfer between ammonia and water on condenser	7.5	8.4
Inability of cooling tower to approach the wet bulb	9.5	10.6
Total	89.6	100.0

Of the total temperature rise, 42.4 per cent cannot be altered; to the rest the engineer can make considerable change if he has a thorough appreciation of what is going on and a knowledge of the underlying laws.

In the plant represented by Fig. 2 a special cooling tower section cools water used to cool the liquid ammonia as closely to wet-bulb as possible. It will be noted that the cooling tower cools the water to the liquid precooler to within 3 deg. of the wet-bulb and that the precooler is able to lower the ammonia temperature to within 5 deg. of the coolest water and so to within 8 deg. of the wet-bulb. It is at this temperature that refrigeration begins for further cooling of ammonia. However, the plant in question, to avoid the necessity of compression of all gas through the entire range of 89½ deg., is so arranged that operation with two back pressures is possible. Ammonia liquid is expanded wet into a liquid forecooler that acts simultaneously as a water forecooler. As this forecooler expands ammonia to a temperature of 31.5 deg., it is plain that the portion of ammonia gas resulting from liquid and water forecooling need only be raised through 67 deg., as compared to 89.5 deg. F.

In the water forecooling sections of the graph there are several things that are wrong. The distilled water used for the coils leaves the heat exchangers too warm, thus requiring considerable more cooling, with ammonia in the forecooler than should be necessary. The city water used directly for raw-water ice enters the refrigerating system 9½ deg. above wet-bulb and is cooled to only 16.5 deg. F. above ammonia temperature in the forecooler. Water from special cooling tower sections should be made to cool the raw water closer to the wet bulb, and the forecooler should cool it closer to the temperature in the forecooler ammonia coils. If this were done there would be less refrigeration required and there would be more high-pressure and less low-pressure ammonia gas. It will also be noted that after raw water is cooled to 48 deg. F. in the forecooler in passing on to the cans it re-absorbs heat equivalent to 3 deg. in temperature. This is not a very large loss, but then, it is one of the items of which there can be a great many in a refrigerating plant, whose proper care creates high over-all efficiency, while the opposite means high power consumptions.

▼

BURNING LOW-GRADE COAL and coke on chain grate and underfeed stokers, the Depford West station of the London Power Company has a good record for operating economy. According to *Engineering* (London), Feb. 5, the B.t.u. per net kilowatt-hour was 14,952 B.t.u. for the ten months' period ending Oct. 31, 1931.

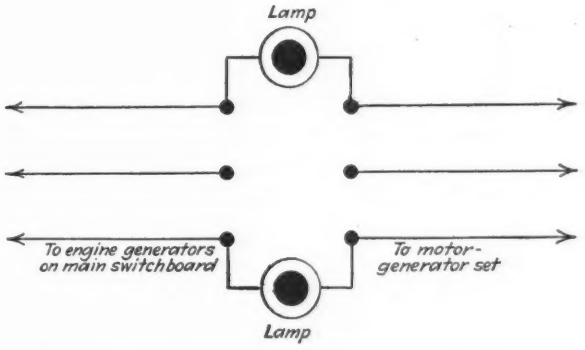
Failure to Phase-Out Generators Causes Service Interruption

By C. W. HOPE

IN OUR engine room there are two switchboards. The main board controls two engine-driven generators and the other is for a synchronous-motor-generator set. The two boards are interconnected and power is distributed to the plant from the main switchboard. The two engine-generators were formerly synchronized by lamps on the main board while the motor-generator set was synchronized with a synchroscope on its switchboard. Usually one engine supplies all the load that it can and the motor-generator set takes the peaks. At night the other engine alone supplies all the load.

It was always difficult to synchronize the engine generators on account of their hunting action and it was decided to connect the synchroscope to the main switchboard and use it for all synchronizing. When the connections were made the motor-generator set was brought up to speed and the synchronizing plug inserted. The needle on the synchroscope rotated the same as usual, and apparently everything was correct when the switch was closed. The results however were rather disconcerting for when things stopped happening all the machine had tripped off the line. From the machine's action it was known that the machines had been connected together when they were out of phase.

We then proceeded to phase out the machine, which should have been done before the switch was closed. Lamps were placed across the switch studs as indicated in



Lamps connected across switch to check the synchroscope indications

the figure and it was found that the synchroscope showed in phase when the machines were really 180 deg. out of phase. The connections to one of the voltage transformers were then reversed which brought the synchroscope needle in-phase position with the lamps dark. We then again tried synchronizing with perfect results and found that it was much easier to phase in the engine generator with the synchroscope than with the lamps.

Connecting the generators together when they were out of phase did not harm them, the service interruption to the service being the most serious part of the mistake. This experience exphasizes the necessity of testing and making sure that the synchroscope connections are correct before connecting generators in parallel for the first time.

What Is A High-Speed Diesel?

By V. L. MALEEV

Professor of Mechanical Engineering
Oklahoma A. & M. College

Popularly and even among engineers an oil engine is classified as being a low- or high-speed unit by the piston speed. Worse yet, an engine of 6-in. stroke is classified with 12-in. stroke as long as both operate at the same revolutions per minute. This is wrong and a simple method of classifying oil engines into low-, medium-, high- or super-high-speed classes by means of a speed characteristic is proposed by the author. This speed characteristic is equal to the piston speed times revolutions per minute divided by 100,000

IN ESTABLISHING the dividing lines between high-, medium-, and low-speed engines by means of a speed characteristic, such factors that are connected with the rotative speed of an engine and influence its behavior and hence its design and construction should be taken in consideration.

In the past, two characteristics have been used in classifying engines in regard to speed: the rotative speed, or revolutions per minute, and the average piston speed, in feet per minute. However neither of these characteristics can be used satisfactorily.

Without any figuring it is evident that a 10-hp. per cylinder engine of $4\frac{7}{8}$-in. bore by 6-in. stroke running at 900 r.p.m. presents a less difficult problem, and is less of a high-speed engine than a 70-hp. engine of 9-in. bore by 12-in. stroke, running at the same speed of 900 r.p.m. It is also obvious that an engine of 475 hp. per cylinder of 18-in. bore by 21-in. stroke, running at 900 r.p.m. can not be built, at least with present-day materials.

Similar objections will be found against the use of average piston speed, c, as a speed characteristic. Its expression may be written

$$c = ns/6,$$

where n is the rotative speed in revolutions per minute and s the stroke in inches. It is obvious that c is directly proportional to s, which, in turn, is proportional to the size or power of an engine, if other things are equal.

Suppose again three engines are compared, this time having same piston speed of 1,000 ft. per min: a 10 hp. per cylinder engine, $4\frac{5}{8}$ in. x 6 in.; at 1,000 r.p.m.; a 70-hp. engine, $12\frac{1}{4}$ in. x 16 in.; at 375 r.p.m., and a 475-hp. engine, 32 in. x 60 in., at 100 r.p.m. In spite of equal piston speeds they belong to three different classes: the 10-hp., 1,000 r.p.m. unit is a high-speed engine, the 70-hp. at 375 r.p.m. engine is a medium-speed, and the 475-hp., 100 r.p.m. unit is obviously a low-speed engine.

This example shows that the piston speed c can not be used as a speed characteristic, although it contains the two necessary basic features, the primary speed factor n and the engine-size factor, the stroke s. Multiplication of n by s, decreases the influence of n too much. In order to restore the proper influence of n and still to retain the influence of s, the speed characteristic may be presented in the form of a product of c and n. To avoid large numbers with many digits it is convenient to divide cn by 100,000. Designating this speed characteristic by c_s, gives

$$c_s = 10^{-5}\, cn$$

or in connection with expression $c = \frac{ns}{6}$ mentioned heretofore,

$$c_s = sn^2/600{,}000.$$

An argument in favor of this equation as a speed characteristic is that the factor limiting the speed of a reciprocating engine, the so-called inertia load, varies directly as the square of rotative speed and as the first power of engine stroke, exactly according to the formula.

It also may be useful to mention why the other dimension determining the size of an engine the cylinder bore, d, does not influence the speed characteristic. With an increase of d the weights of the reciprocating parts

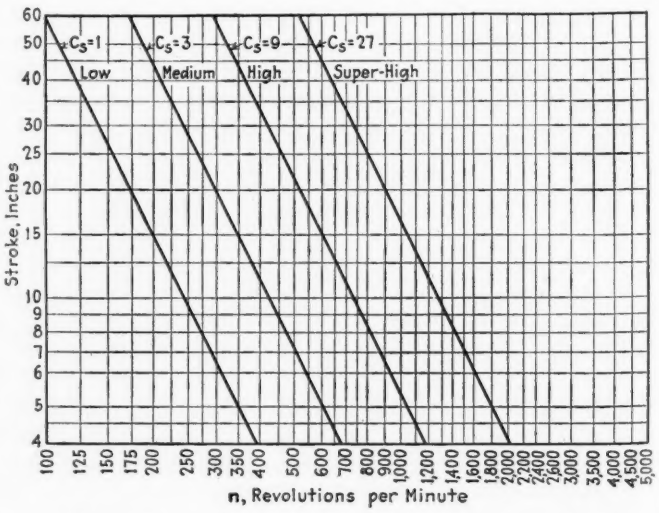


Fig. 1—Chart for classifying engine type with respect to speed from stroke and r.p.m. data

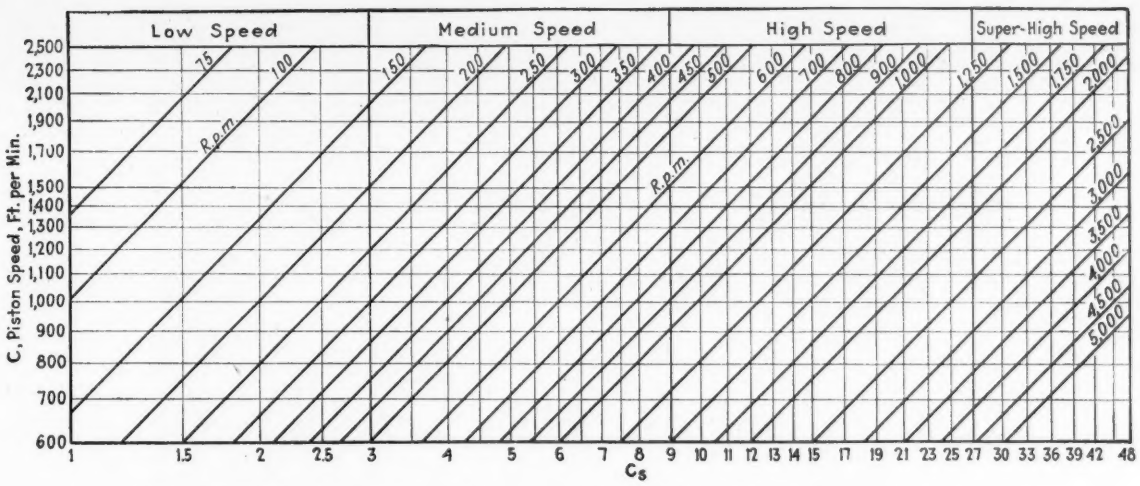


Fig. 2—Chart for determining engine speed classification based on piston speed and r.p.m.

and the inertia forces increase, and in a properly built engine the dimensions of the parts subjected to these forces are increased in the same proportion, so that the stresses and unit pressures are the same and independent of d.

Having established a method of computing the speed characteristic, the next step was to determine the limits between which an engine should be classified as a low-, or medium-, or high-speed one.

When a certain feature or characteristic changes gradually from a low to a high value, it is useful to insert a medium group between the two main groups and, also, additional groups with a prefix "extra" or "super" for values outside the main groups. A classification of engines selected according to these requirements and the corresponding speed characteristics are given in Table 1. The speed-characteristic limits were determined by computing the characteristic c_s from the expression $c_s = 10^{-5}\ cn$ for a large number of actual oil engines and taking in consideration their behavior in regard to the speed factors as outlined.

The dividing points between the speed-characteristic limits for the different groups are more or less arbitrary. On the other hand, there must exist a certain regularity between these figures. The best results were obtained with an increase of the characteristic limits in a geometrical progression with the ratio 3.

TABLE I — SPEED CLASSIFICATION OF ENGINES

Classification of Engines	Abbreviated Designation	Limits of cs	Limits in Existing Engines n r. p. m.	c, Ft. Per Min.
Low speed.....	L	1—2.9	95— 350	687—1,083
Medium speed..	M	3—8.9	300— 800	750—1,333
High speed.....	H	9—26	700—1,600	1,000—2,000
Super-high speed	S	27—80	1,500—2,500	1,750—2,330

In establishing speed characteristics for low- and medium-speed engines it is advisable to take the figures with the first decimal, whereas the speed characteristics in the two high-speed classes can be rounded up to whole figures.

For the sake of comparison, the limits of n and c of various oil engines taken from manufacturers' catalogs and classified according to the present proposal are given in the last two columns of Table 1. These figures follow the trend of the new speed characteristics very well, but with considerable overlapping, which is the reason for the proposal of a definite speed characteristic.

In order to check the basic correctness and consistency of the speed characteristic and its limits as given in Table 1, this method was applied to the two examples with three engines in each mentioned at the beginning of this article. Table 2 shows that the first three engines, with an equal rotative speed of 900 r.p.m., are placed by the speed characteristic c_s in three different speed classes, medium, high, and super-high, exactly in accordance with the previous analysis based on general engineering considerations. In a similar manner the three engines with equal piston speed of 1,000 ft. per min. come also into three different clases, high, medium, and low speed.

TABLE II — SAMPLES OF CLASSIFICATION

Hp. Per Cyl.	Bore In.	Stroke In.	R.P.M.	Piston Speed, Ft. per Min.	Speed Characteristic cs	Abbreviated Designation
10	4¾	6	900	900	8.1	M
70	9	12	900	1,800	16.2	H
475	18	21	900	3,150	28.4	S
10	4¾	6	1,000	1,000	10	H
70	12¼	16	375	1,000	3.8	M
475	32	60	100	1,000	1.0	L

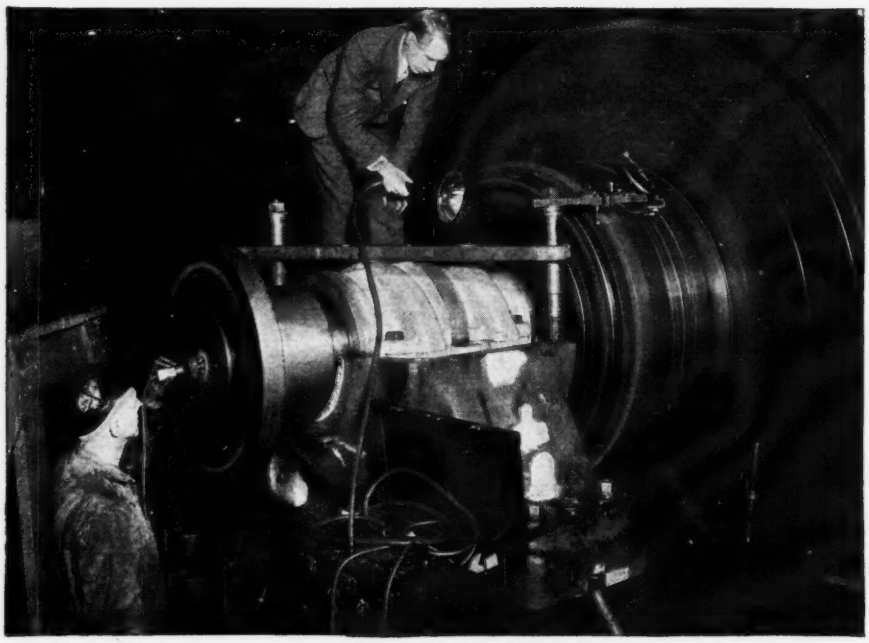
For practical use a convenient chart, Fig. 1, may be drawn on logarithmic paper with piston stroke s in inches as ordinates and engine speed n in revolutions per minute. as abscissae. In this system of coordinates lines of constant sn^2 become straight inclined lines. With the four limit lines c_s=1, 3, 9 and 27 drawn in, the classification of any engine may be determined by finding the intersection of the horisontal line of its stroke with the vertical line corresponding to its speed in revolutions per minute.

Another chart, Fig. 2, along the lines proposed by E. C. Magdeburger, may be drawn, taking piston speeds c as coordinates and characteristics c_s as abscissae, the revolutions per minute becoming straight lines inclined 45 deg. The speed characteristics c_s is found by extending the horizontal line corresponding to the known piston speed c until it intersects the inclined line corresponding to the revolutions of the engine; the general classification can be read then on top of the chart and the value of c_s on the horizontal scale.

The following general conclusions can be drawn: The use of the proposed speed characteristic c_s gives a consistent means of judging oil engines in respect to speed. The system of classification as presented in Table I is sound and is without irregularities.

This system presents means of showing in a concise way what has been done by other engine builders and can serve as a guide to engine designers.

The acceptance of the proposed speed characteristic will be of benefit to the development of oil engines.



With the Stroboglow, machine parts rotating at high speeds may be investigated

Electron-Tube Applications to Power Generation and Control

Electron tubes are being used in a large number of applications for rectifying alternating-current, automatic synchronizers, automatic voltage regulators, and in metering and control systems. Several of these are described, with particular attention given to the Thyratron and Grid-glow tube operation, as these constitute another group of electron tubes in addition to the two discussed in the March 22 number.

WHEN an electron tube is filled with gas at a low pressure an effect is obtained known as gas amplification, that increases the flow of the current may times over that in a vacuum. This amplification is produced by the electrons, when traveling from the filament to the plate, colliding with gas atoms and releasing electrons from them that are attracted to the plate. These electrons, in turn, collide with other gas atoms and release additional electrons. As a result of this action many more electrons reach the plate than would if the gas were not present, and the current flow through the tube is increased in proportion.

A thyratron is a three-element tube filled with mercury vapor and may be considered to be a grid-controlled mercury-arc rectifier. When the grid is energized by a voltage properly related to the power applied to the tube it is possible to control the output of the tube, the same as that of the three-element vacuum type.

Grid control of a vacuum tube is materially different from that of the thyratron. As shown in the previous article, the output of the vacuum tube is continuously under the control of the grid. If the grid potential is made sufficiently negative the output of the tube is reduced to zero. As the grid potential is made less negative, or changed to positive, the output of the tube can be gradually increased to its maximum. The reverse of this operation will bring the tube's output back to zero.

In the thyratron, as in the vacuum tube, there is a critical negative potential above which the tube will not pass current. As soon as the grid potential is decreased below the critical voltage, ionization begins and the tube passes current, provided the anode is positive with respect to the cathode. However, after current starts to flow the grid has no appreciable affect on it; that is, the grid can start the flow of current but it cannot stop it. The grid can again gain control, to keep the current from starting if the flow ceases long enough for the mercury vapor to deionize.

When an alternating voltage is applied to the tube it will pass current only when the anode is positive, consequently current flows only during one-half of each cycle. During the other half cycle no current flows through the tube, ionization of the gas ceases and the

grid can regain control to prevent the current flow from starting again, if this is desired.

Figs. 1 and 2 show the simplified circuit of a thyratron rectifier. The grid transformer supplies a potential to the grid, which will be assumed to be of correct polarity for current to flow from the anode to the cathode. The filaments are heated from a section of the main transformer's secondary. When the power transformer's secondary potential is in the direction of the arrow the anode of tube *A* is positive and a current wave will flow through the load as indicated by the arrowheads, Fig. 1. On the next alternation of the cycle the voltage of the transformer's secondary will be reversed, making the anode of tube *B* positive and current will flow during this alternation as indicated by the arrowheads, Fig. 2. In this way the alternating current from the transformer is rectified to a pulsating current similar to the curves, Fig. 3, that flow through the load.

In Figs. 1 and 2 the potential of the grid has been assumed to be the same as the plate and in phase with it, consequently operation is practically the same as though the grid were not present. By causing a phase shift in the grid voltage it is possible to prevent the current flowing for part of the alternation and therefore to reduce the output of the tube. Fig. 4 indicates the relation between the plate and the grid voltages, Figs. 1 and 2. In all cases, during the rectified waves the grid voltage is above the critical value at which current will start to flow from the plate to the filament, consequently current flows during each entire half cycle as indicated by the shaded areas.

Assume that the grid voltage is thrown out of phase with the plate potential by an angle such as in Fig. 5. During the period represented by *ab*, when the plate is positive, the grid is at a negative potential higher than the critical, below which the current will flow through the tube. As a result current is prevented from passing through the tube until point *b* is passed, when the negative potential on the grid drops below the critical. At that point current starts to flow and continues for the remainder of the alternation as represented by the shaded area.

From the foregoing it is evident that the more the grid potential is out of phase with that on the plate the smaller will be the portion of each half cycle when current will flow through the tube. When the grid potential is 180 deg. out of phase with that on the plate no current will flow through the tube. For example, in Fig. 1 if the grid connections to the transformer were reversed the thyratrons would cease to function, because the grid would have negative potential above the critical during each half cycle when the plate is positive. This relation between plate current and grid voltage provides a flexible method to control the current through the thyratron.

One way of causing a phase shift between the plate and grid voltages is illustrated in Fig. 6. The primary voltage E is in phase with the plate voltage and the grid is connected between the middle point of the transformer and junction of a reactor X and resistor R. As the reactance of X is varied grid voltage E_g is caused to rotate with respect to E to provide a relation between the grid and the plate voltages that will give the desired control of the tube.

A typical way of applying this system is to use a solenoid coil for the variable reactor. The reactance of the magnetic circuit is changed by varying the position of the core in the coil. In a typical case moving a 2-oz. core $1\frac{1}{2}$ in. is sufficient to change the thyratron's output voltage from zero to a maximum. A small rotary regulator, similar to a selsyn motor, may also be used to change the angle between the plate and grid voltages.

The diagram, Fig. 7, shows a thyratron connection for

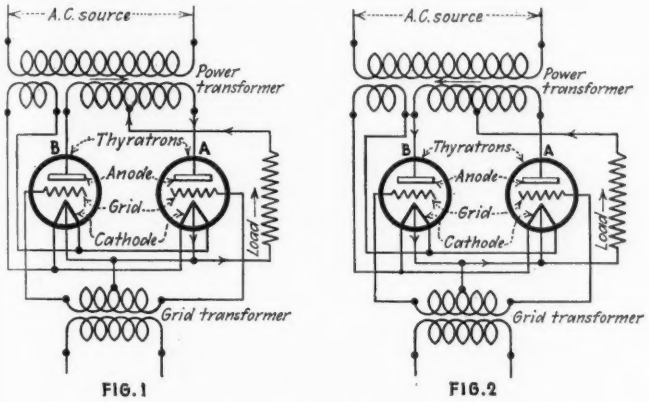


FIG. 1

FIG. 2

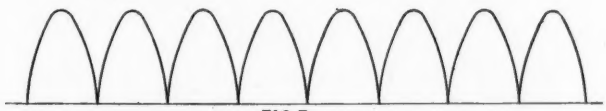


FIG. 3

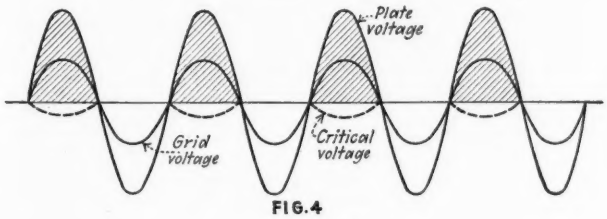


FIG. 4

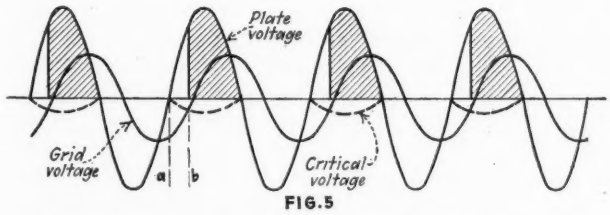


FIG. 5

Figs. 1 to 5—Simplified diagram explaining the operation of the thyratrons

Figs. 1 and 2—Simplified diagrams of Thyratron connections. Fig. 3—Unregulated rectified current supplied by a Thyratron. Fig. 4—Relation between the plate, grid, and critical voltages in a Thyratron with the plate and grid voltages in phase, under which conditions the grid has no control. Fig. 5—Relation between the plate and grid voltages, when they are out of phase and the grid has control of the output of the Thyratron.

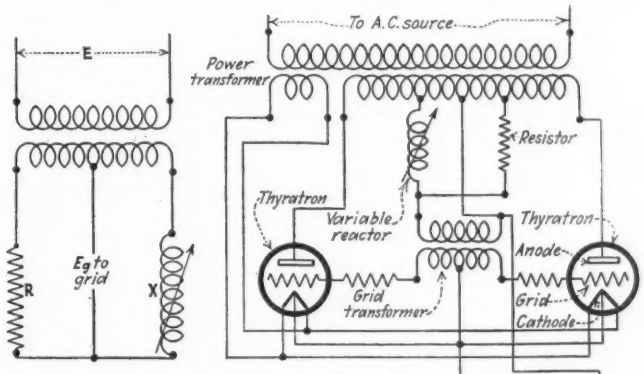


Fig. 6—Elementary diagram of a phase-shifting method of grid-voltage control of a thyratron

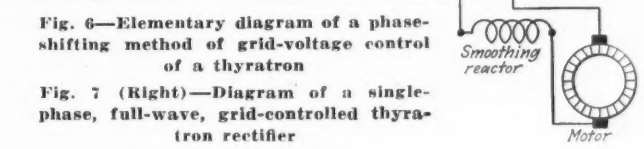


Fig. 7 (Right)—Diagram of a single-phase, full-wave, grid-controlled thyratron rectifier

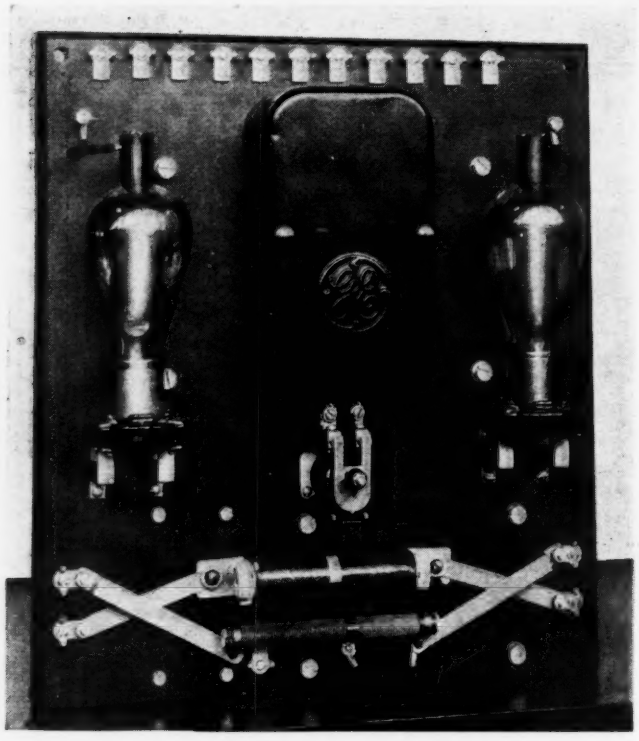


Fig. 8—Thyratron panel for controlling the speed of a 1-hp., 230-volt motor by armature control

supplying power to a direct-current motor. This diagram is similar to Figs. 1 and 2 except that the grid circuit is taken from the main transformer and a resistor and reactor has been included in that circuit to control the phase angle between the grid and anode voltage. The variable reactor provides a method of controlling the output voltage, and consequently the motor's speed, by the simple expedient of changing the phase angle of the grid voltage with relation to that of the plate voltage. Fig. 8 shows a thyratron panel for controlling the speed of a 1-hp., 230-volt motor by armature control. The two thyratrons are at the sides of the panel. On the front of the panel are also mounted the anode contactor, field-protective relay and the grid resistor. The power transformer, direct-current smoothing reactor and grid transformer are mounted on the back of the panel.

Instead of using the thyratron to control the voltage to a direct-current motor's armature it may be applied to the field only. In this way the speed of a much larger motor can be controlled by a thyratron than by armature voltage regulation. For example, a unit that could supply power to a 5-hp., 230-volt motor would be capable of supplying field current to a motor requiring 5-kw. excitation at 250 volts, or the field current to a motor of several hundred horsepower.

The possible applications of thyratrons are many and varied. For example, an automatic combustion control system has been developed that uses selsyns and thyratrons. A description of this system will be published in an early number of *Power*.

Where the speeds of two or more conveyors are to be synchronized, it may be done by thyratrons controlling the field current of the conveyor motors.

Grid-glow tubes, which are also of the gas-filled type with grid control, are used for a wide variety of power applications and control purpose. They have been made to control 180 amp. at 5,000 volts, 900 kilowatts.

Lighting is another field in which thyratrons and grid-glow tubes are finding wide applications. Many beautiful illumination effects, both in auditorium and out of doors, are made possible by tubes of these types.

One of the great possibilities for tube of these types is in power-transmission work. It is freely predicted that electron tubes will make high-voltage direct-current power transmission commercially possible. One combination of these tubes at the supply end of the line will convert high-voltage alternating current into direct current for transmission. At the receiving end of the line the direct current will be converted into alternating current through another set of tubes for distribution.

In addition to the many advantages of direct-current transmission, such as increased capacity of lines and reduced losses, the tubes converting the current from one form to the other can also be used as the switches. In case of trouble on the line, giving the grid an opposite potential from that of the plate will stop the current flow in the circuit, as previously explained. It is therefore not unlikely that the ponderous oil circuit breakers now associated with high-voltage transmission lines may be not required in the future.

For many years electric precipitators have been used to remove solids from flue gases on their way to the stack. In this process unidirectional current is required at from 30,000 to 60,000 volts. This current has been

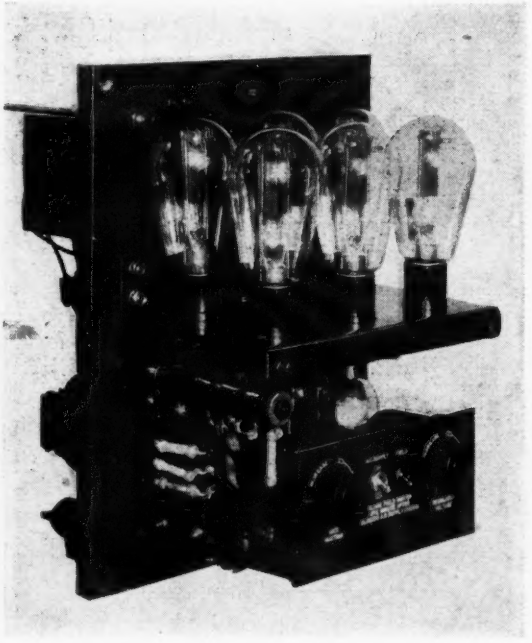


Fig. 9—Electron-tube type automatic generator-voltage regulator

supplied by a mechanical type of rectifier. These rectifiers are now being replaced by electron tubes.

Electron tubes are coming into use as voltage regulators, a number of developments of this kind having been made. Fig. 9 shows an automatic regulator of this type for direct-current generators. Because the electron tubes operate without time lag and friction and require such a small amount of control power, the regulator has a sensitivity and speed of response that is not equaled by mechanical types of voltage regulators. Electron-tube automatic voltage regulators have also been developed for alternating-current generators. Except in experimental form, electron-tube automatic voltage regu-

lators have been built for generators of a few hundred kilowatts capacity only.

Automatic vacuum-tube type synchronizers are available that require only 5 volt-amperes to operate them, compared to 66 to 150 needed by the mechanical types. Energy for the vacuum-tube type may be taken from condenser-type bushings when the mechanical type requires potential transformers. The vacuum-tube synchronizer's operation involves current based on the beat frequency between the two circuits, which is rectified in copper-oxide rectifiers and used to control the grids of the vacuum tubes. Two simple adjustments are made by radio-type rheostats. One changes the frequency difference at which the device will synchronize (usually $\frac{1}{6}$ cycle) the other adjusts the angle of advance to allow the circuit breaker to close at exact synchronism. This synchronizer, Fig. 10, is reported to be twice as accurate as the most skilled human operator.

Where there are several generating stations or substations on a power system it may be desirable that the load dispatcher have information as to conditions on various parts of the system. Several methods of transmitting this information, telemetering as it is called, have been developed, some of which use electron tubes. In one, a varying-frequency telemetering system, an electron-tube beat-frequency oscillator is employed, the frequency of

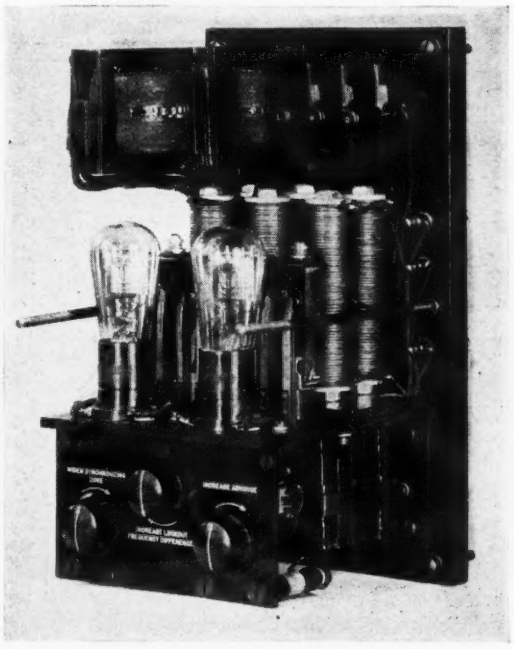


Fig. 10—Electron-tube type automatic synchronizer for alternating-current generators or systems

which is controlled by a small condenser mounted upon the movement of the instrument, the reading of which is to be transmitted. The reading is reproduced at the receiving end by a frequency meter having a scale corresponding to that of the transmitting meter. The system is suitable for transmission over wire conductors or by means of carrier current.

A photo-electric recorder is now available, Fig. 11, that combines the advantages of a direct-acting recorder with those of a sensitive instrument. This is accomplished by providing a separately excited recording element to make the record. A sensitive indicating instrument controls the position of the recording element

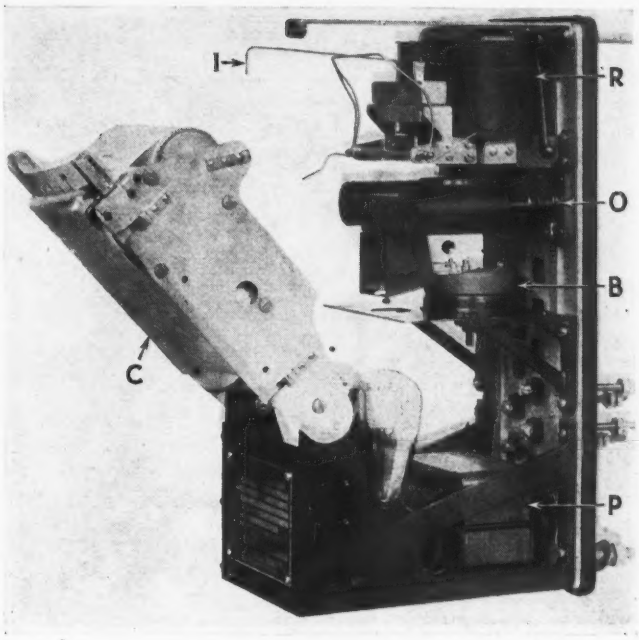


Fig. 11—Interior of a photo-electric recorder combining the advantages of a direct-acting recorder and a sensitive instrument

B the basic instrument; *C* a chart carriage; *I* inking pen; *O* optical system; *P* power unit; and *R* recording element.

so that the record obtained represents the reading of the basic instrument. The loss in the basic instrument is the only power required from the measuring circuit. The link between the basic and recording elements consists of a combined optical system and photo-electric and amplifying-tube circuit.

The basic element rotates a galvanometer mirror through an angle corresponding to its reading and can be made more sensitive than an indicating instrument with a pointer. On the other hand, the recording element may be designed to have as much torque and be as heavy and sturdy as desired without affecting the basic element or measured circuit. This type of recorder may be used for most any application where a sensitive recorder is required for a continuous record of electric values, such as temperature, pressure, vibration, smoke density, etc.

Electron-tube devices have been brought to the aid of the engineer in studies of objects rotating at high speed. In this field may be mentioned the stroboglow (see photo on first page), a portable device that makes rotating objects appear to stand still or rotate at very slow speeds. In this device the light bulb is a powerful grid-glow tube which is lighted by a heavy oscillatory current discharge of a condenser. By means of this equipment the action of the blades of steam turbines, the meshing of gear teeth, the behavior of armature bands, etc., may be studied when rotating at full speed.

Vacuum tubes as part of a control system for automatically leveling elevators is coming into extensive use. A simplified diagram of such a system is shown in Fig. 13. The essential parts of this system are the three-element vacuum tube, the plate coil and grid coil in proximity to each other so that their fields couple if the grid coil is suitably tuned by a condenser across its terminals. Such a system if connected to a source of direct-current power will have an oscillating current produced in it. The frequency at which the circuit will oscillate will be determined by the frequency of the tuned grid

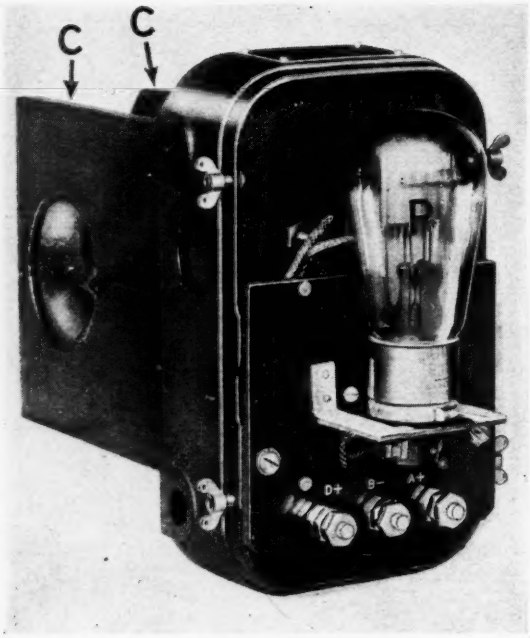


Fig. 12—A Pliotron unit with a three-element vacuum tube *P*, the plate and grid coils being supported at *C*

circuit. For an elevator leveling unit a frequency of about 200 kilocycles is used.

One of the Pliotron units used in elevator service is shown in Fig. 12, *P* being the Pliotron tube, the grid and plate coils being supported in the parts *C*. About one inch of air space is provided between the grid and plate coils. As long as the circuit oscillates, because of the high frequency, no current will flow through the relay coil, Fig. 13, but it will flow freely through the bypass condenser.

The Pliotron leveling devices are mounted on top of the car. In the hoistway at the floor leveling zones are metal plates so placed that they pass between the plate and grid coils. When one of these plates comes between the plate and grid coils it breaks the couple between them, stops the circuit oscillating and allows current to flow through the relay coil and the Pliotron tube. This

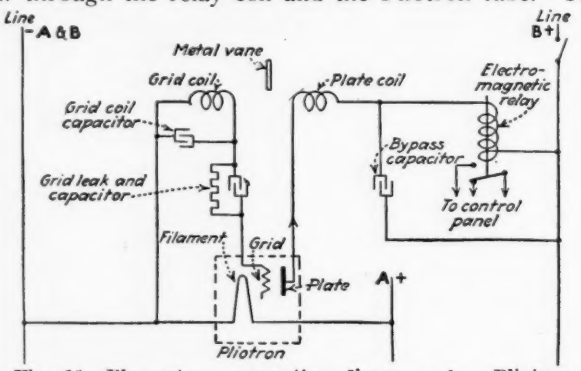


Fig. 13—Elementary connection diagram of a Pliotron elevator-leveling control system

will cause the relay to function and bring into operation the control to slow the car down and stop it at the floor. The number of Pliotrons required depends on the speed of the car and other conditions; on a high-speed car five may be used to slow down the car and level it at the floor.

Acknowledgment is hereby made of the assistance rendered in the preparation of this article by the General Electric Company and Westinghouse Electric & Manufacturing Company.

Flow of Water in Rubber Lined Hose

OCCASIONALLY it is necessary to know the drop in hydraulic head due to passage of water through rubber hose, hard-rubber pipe, rubber-lined pipe and kindred articles. Much work has been done and several formulas are in use for the resistance of flow in iron pipe, the generally accepted figures being those proposed by Hazen and Williams

$$V = K\,(c\sqrt{r}\sqrt{s})$$

Where V = Velocity in ft. per sec.

$$K = 1.318\left(\frac{D}{4}\right)0.13 \times S\,0.04.$$

C = A constant for each type of hydraulic surface, determined upon by experiment.

R = Area of wet cross-section ÷ circumference of wet cross-section.

S = Pressure head in ft. ÷ length of straight pipe required to run from end to end.

D = Diameter in ft. of wet cross-section.

Tables of the above for C—100 (average iron pipe in service) expressed in cubic feet per minute and gallons per minute are readily available.

$$Q = AV \times 7.48 \times 60$$

Where Q = Quantity in gallons per minute.

A = Area of wet cross-section in feet.

V = Velocity in feet per second.

Experiment has shown that for smooth-bore hose, whether of mandrel cure or not, C closely approximates 140.

The accompanying table, prepared by engineers of the B. F. Goodrich Rubber Company, is a guide for determining choice of an installation. Where the indicated

FLOW OF WATER IN RUBBER HOSE, RUBBER-LINED PIPE, ETC.

Loss in pounds per 100 ft.

U.S. Gal per Min.	Actual Inside Diameter, Inches										
	¼	⅜	½	1	1¼	1½	2	2½	3	4	5
¼	0.5										
1½	2.8	0.7	0.5								
2½	7.6	2.1	1.1								
5	28.5	9.6	4.0	1.1	0.4	0.2					
10	101.0	33.8	14.0	4.0	1.2	0.5	0.2				
15		70.0	30.0	8.9	2.5	1.1	0.4	0.1			
20		112.0	53.0	14.0	4.3	1.8	0.7	0.2			
25			79.0	22.0	6.5	2.9	1.0	0.3			
30			112.0	31.0	9.2	4.0	1.4	0.4	0.1		
35			147.0	41.0	12.0	5.3	1.8	0.5	0.2		
40				53.0	15.0	6.7	2.4	0.6	0.3		
45				66.0	19.0	8.4	3.0	0.8	0.4		
50				80.0	24.0	10.0	3.6	1.0	0.5		
60				101.0	35.0	14.0	5.1	1.4	0.6		
70					45.0	19.0	6.6	1.8	0.8		
80					58.0	24.0	8.6	2.3	1.1		
90					71.0	30.0	11.0	3.0	1.4	0.3	
100					88.0	37.0	12.5	3.5	1.7	0.4	0.1
125					132.0	55.0	20.0	5.3	2.5	0.6	0.2
150					183.0	78.0	27.0	7.5	3.5	0.7	0.3
175						100.0	37.0	10.0	4.6	1.1	0.4
200						133.0	46.0	13.0	5.9	1.4	0.5
250							70.0	19.0	9.1	2.1	0.7
300							95.0	27.0	12.0	2.9	1.0
350							126.0	36.0	17.0	4.0	1.3
400								46.0	21.0	5.1	1.7
450								57.0	26.0	6.3	2.1
500								70.0	32.0	7.4	2.6
1,000									116.0	27.0	9.6
2,000										100.0	32.0

Based on Hazen and Williams formula with C-140.

flow figures are close to minimum it will be advisable to ascertain from the rubber manufacturer the actual inside diameters of the goods. In general, mandrel-cured hose may be assumed to have an over-all variation from the nominal diameter of $\frac{1}{64}$ in., while internal-pressure-cured hose has $\frac{1}{16}$-in. variation up to 2 in. I.D. and $\frac{3}{32}$-in. variation over 2 in. I.D.

PRACTICAL AIDS TO OPERATION

Repair Jobs Not Easily Forgotten

IT MAY BE interesting occasionally to turn our minds from up-to-date things and consider some of the difficulties faced by the older generation of engineers. The writer worked on a job at a time when no power drills were available. It was in the engine room of a large cotton-spinning mill, the various floors of the mill being driven by gearing from a horizontal steam engine.

The alteration involved retaining the front of the engines and gearing and cutting the old cast-iron engine bedplate just abaft of the crosshead slides, removing the old cylinders and replacing them with compound corliss cylinders, air pump and condenser. The new rear bedplates were to be secured to the forward parts at the "cut."

The iron of the old beds was very thick, strongly ribbed, and extraordinarily tough, working like mild steel under the drills and chisels. A long wooden straightedge was carefully made at the shop beforehand and the old beds were chalked, scribed across and down the vertical sides and center. Then the cutting was done by hand ratchet drills set under goose neck drill stands and started by the erectors, of whom the writer was the youngest—a last year apprentice, in fact. The holes were driven through by teams of mill hands who tried to beat one another's time per hole. The work went on day and night continuously; when a team tired a rested team at once took up the task.

The holes, of course, were drilled as close as possible, the old rear bed plates were broken away and then the erectors had to use hand chisel and hammer and chip the joint face flat. The long straight edge was used; it reached nearly the full width of the engine house; and toward the end red lead was used on the edge of the straight edge and the joint face made so that each of the two beds (high-pressure and low-pressure) was straight and true and also in line with the other bed and both were parallel with the center line of the crankshaft. Toward the finish files were used.

It may interest young men who have only seen concrete poured foundations to know that these old foundations were of very large blocks of "ashlar," hewn, dressed and squared stone, and this old ashlar was used again.

The new baseplates were placed in position over the old ashlar, leveled up and the grooves chipped at intervals around the edges by the stone masons to take short wood pegs, previously prepared, thus setting the mark for the new and lower level of the rear base. Next the new baseplates were removed and the masons rapidly dressed the top of the ashlar nearly down to the mark. Then the time honored practice of "rubbing down" the new baseplates was followed. The old masons and erectors were very expert at this and a good job was secured.

Los Angeles, Calif. J. STEVENSON.

Quick Check of Motor Loads

A QUICK method for the determination of the load on an electric motor is one of the important points every operating engineer should have at his fingertips. When the engineer walks through the turbine or engine room he glances almost unconsciously at the throttle and notes its opening, which means load. A large majority of the electric motors in common use do not have load instruments permanently connected into their circuits. The way to arrive at the load is by the temperature. If one will measure the temperature of a fully loaded motor he may then say that any other motor of like design at this temperature is fully loaded.

With a little experience one can quickly tell the approximate load condition of the motor by feeling it.

With the squirrel-cage motor, which is one of the most common types in use, the place where the temperature must be watched is the stator winding. Place the hand on the stator laminations or the motor frame, the length of time it can be left there is very short when fully loaded, due to the heat. Either place is well away from any rotating part, or any part which can possibly be alive if the motor is properly installed and grounded. Of course, near air ducts the metal will not be quite as hot as where there are no air currents to have a cooling effect.

Most motors are rated for a normal full-load temperature of 176 deg. F. so that when motors are found operating at this temperature it is time to check the load with an ammeter. It cannot be emphasized too strongly, however, that the load-limiting factor in motors, or almost any other piece of electrical equipment, is the temperature of the insulation. If the equipment is rated at 176 deg. F. this temperature can not be exceeded by any great amount without permanently injuring the insulation.

All of the electrical losses in a motor are dissipated in the form of heat. The largest part of this heat is, of course, generated in the copper coils in the rotor or stator winding. This means that the copper is hotter than any of the iron parts on the outside. A motor may be operated for a few minutes at a high overload provided it is allowed to cool afterward. P. CILLEY.

Salem, Mass.

Corrosion of Condenser Coils

WITH refrigerating condensers there is often a short length of pipe at the coil ends which is alternately wet and dry. This is favorable to rusting and corrosion of the metal. The remedy is to scrape off any rust and clean the pipe from the flange at the header to a point at which the pipe is continually wet. The pipe should then be painted with bitumastic paint over the whole area which has been cleaned.

While this paint is still wet a strip of canvas should be wound over the coil spiral fashion. This canvas should be given a coat of bitumastic paint, then a second layer of canvas should be wound over the coil in a similar manner to the first. As soon as the underlying paint is dry the second canvas layer should be painted. This will give effective protection. The paint will effectively seal the canvas to the metal. W. E. WARNER.

Herts, England.

CURRENT COMMENT

Prefrozen Cores

"PRECOOLING CORE WATER," as discussed by Mr. Knoy in the Feb. 9, issue, suggests the possibility of a still greater saving. Instead of filling cores with water, let them be filled first with ice. The saving would be governed by the completeness of the ice filling.

The ideal way would be to insert an icicle of the average core shape, adding enough precooled water to fill the space. As this is a difficult shape to freeze and handle, the next best is ice crushed small enough to easily enter the core, tamped for maximum filling.

Crushed ice, when tamped, will fill at least 50 per cent of the space, if in large chunks. Mr. Knoy shows that precooling core water from 80 deg. to 40 deg. reduces core freezing time from 12 hr. to 9.5 hr. Using his case, a core 50 per cent water would freeze in $0.50 \times 9.5 = 4.75$ hr., or without precooling, the time is $0.50 \times 12 = 6$ hr.

The ice used for cores could be the poorest cakes produced, such as slow freezing, cracked or not quite clear, as the best cores are seldom crystal clear. Crushed ice traps some air bubbles, larger chunks holding less air, making clearer ice. The cost of core ice would be less than that of marketable cakes, as partly frozen cans are as good as solid cakes for crushing, dispensing with core pulling. The net saving in time would be offset a little by the one can in several dozen used for cores, and the small items of crushing and handling. G. BOYD.

Lenover, Pa.

Pipe-Jointing Compounds

HAVING READ the letter by Norman G. Glattfetter in the Feb. 2 number on "Red and White Lead for Pipe Joints" and the comments from other contributors on the same subject, I am prompted to tell of a compound for pipe threads that was suggested to me and which I personally have tried out on lines carrying both steam and hot water at 150-lb. pressure.

The idea held by the maker of the compound was that it would serve as a combination lubricating, grinding, filling and non-hardening pipe-joint dope. He boasted of never having a joint leak, irrespective of pressure, on iron or brass pipe if the pipe and fitting threads were in reasonably good condition. Furthermore, the joint could always be separated with comparative ease after long service.

The compound consisted of a mixture of five parts by weight of powdered graphite to one part by weight of finest flour of emery made into a fairly thick paint with cylinder oil, the paint being used on the male threads only. JAMES E. NOBLE.

Toronto, Ont.

The Malone Water-Expansion Engine

J. F. J. MALONE of England has recently proposed a novel engine operated by the expansion of water. This was described in *Power,* Sept. 1, 1931.

There is no doubt that Mr. Malone's process would be practicable if certain conditions could be met with. After all, the caloric engine of old is to be revamped in an improved form.

In an auxiliary cylinder (see Fig. 1), a medium is in alternate succession carried by a ram from a hot zone at one end into a cold one on the other. This auxiliary cylinder is connected with a main cylinder.

When the medium expands as a result of its transfer to the hot zone, its expansion is transmitted to the piston working in the main cylinder. This actuates a crank drive in the usual way. When the main piston moves backward the medium is cooled by the auxiliary cylinder.

At first sight, a machine of this description would seem to offer no thermic gains. But it is improved by a regenerating device which increases the economy. On its way between the two zones in the auxiliary cylinder the medium passes through heat-absorbing and heat-delivering elements which accumulate the heat.

Noting that the auxiliary cylinder eccentric is 90 deg. ahead of the main crank, that outward movement of the auxiliary plunger heats the liquid and that inward movement cools it, the ideal performance of the Malone engine would be as follows: With the working piston on its dead center, the medium expands isothermally. The expansion work is balanced by heat introduced under constant temperature from the hot end of the auxiliary cylinder. The working piston advances. Then the heat supply is discontinued and the medium in the auxiliary cylinder is pushed toward the cold end. On its way it transfers heat to the regenerator and cools down. Meanwhile expansion goes on adiabatically until the working piston has reached its outer dead center. The temperature falls.

Next, compression begins isothermally. The compression work is carried out of the system from the cold end of the auxiliary cylinder, the medium in which is finally pushed again to the hot end. Compression goes on adiabatically until the initial condition is reached again. The temperature is raised throughout the whole body up to the initial value by means of heat given off by the regenerator and by the adiabatic compression.

From the foregoing it follows that this working process corresponds to the Carnot; hence it would allow of obtaining the highest efficiency possible with the given temperature range. To achieve this, however, the regeneration must be perfect; that is, all the heat corresponding to the quantity and the specific heat of the working medium, and to the difference of the temperatures of the cold and the hot cylinder ends, must be given off in the regenerator and transferred back to the medium within the short period that is allowable. Any radiation from the regenerator to the outside would not be admissible, while heat transference and conductivity must be excellent.

Gases do not comply too well with this specification. That is why Mr. Malone proposes to use water under critical conditions, for which the coefficient of expansion is nearly the same as for gases, while for water under ordinary conditions it is so low that the increase in volume caused by heating would hardly suffice to drive an engine.

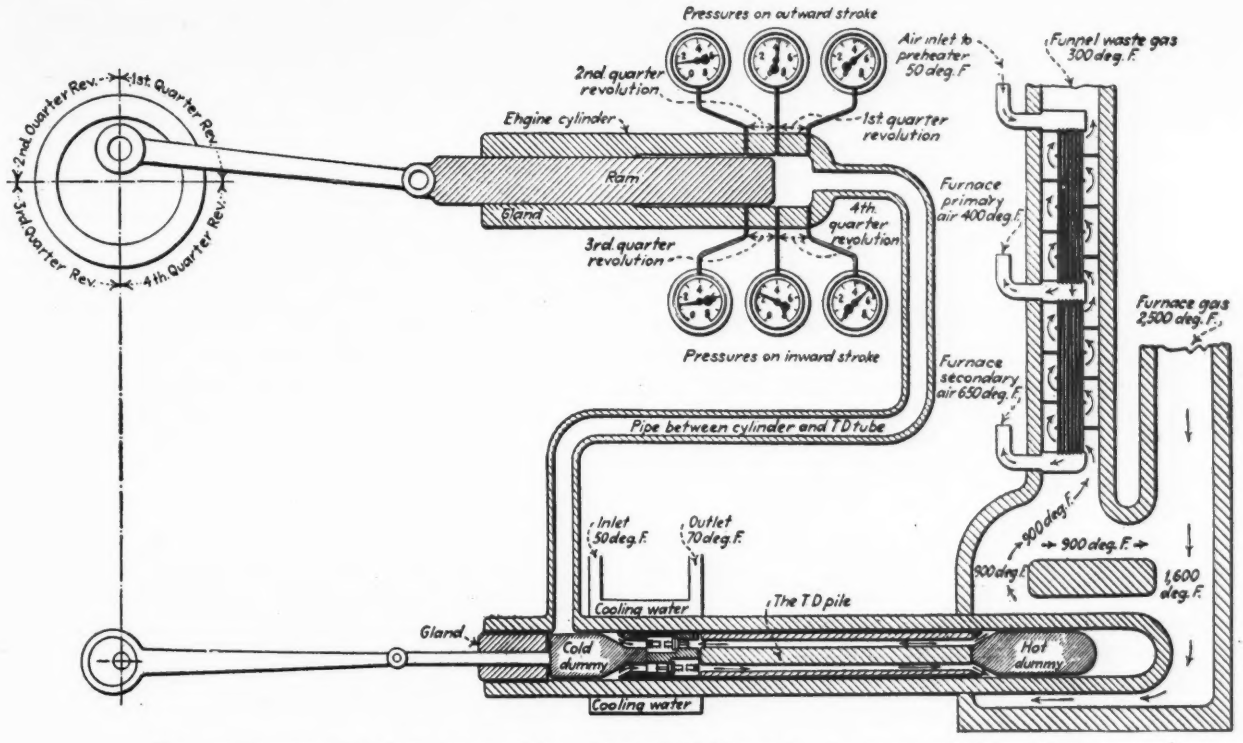


Fig. 1—Diagram of Malone water engine. Power is delivered by the upper cylinder. Lower cylinder (eccentric 90 deg. ahead of main crank) is used to heat and cool the fluid by a regenerative operation

Concerning the question whether an "expansion engine" working in this perfect way would be able to reach the efficiency of the Carnot cycle, it may be stated that any cycle coupled with a perfect regenerative process would tend toward better efficiency. Thus, the ordinary saturated-steam cycle would reach the corresponding Carnot efficiency if there were a perfect regenerative process; that is, if, in this case, there were an infinite number of bleeding stages by which the feed could be heated up to the temperature prevailing in the boiler. Even if there were no losses, an infinite number of bleeding stages would, of course, be impracticable. So far the Malone process would be an improvement.

The operability of the Malone set has been proved. It must, however, be doubted whether this process can be applied in larger units. The high efficiency expected would be dependent on the extent to which the perfect method of working could be realized.

The change of state in the actual engine differs considerably from that in a Carnot cycle. Fig. 2 shows the pressure plotted against the volumes of the Carnot and the actual engines. The difference between these two is still more manifest in Fig. 3, the entropy diagram, where the useful work performed in the Carnot cycle is shown as a rectangle between two temperature limits. The heat supplied is represented by the rectangle extending down to the zero value of the absolute temperature. It is seen that although the heat supplied is less with the actual engine than with the Carnot cycle the heat converted into work is still smaller.

Apart from this, there is still the question how the economy of a Malone plant would work out in its totality. As mentioned before, one end of the auxiliary cylinder must be permanently maintained at a high temperature, the other at a low temperature. The latter condition can be obtained by water or air cooling of the one end. The difference between the temperatures of the hot and the cold ends must be considerable. This can be accomplished only by using hot flue gases approximating in their temperature those existing in an intense fire. There are no suitable materials.

The exit temperature of the gases, too, would be rather high, but as there is no economizer to be heated, the heat could only be utilized by further preheating of the air for combustion. Otherwise, with the gases escaping at high temperatures, the over-all efficiency of the process would be greatly prejudiced. However, utilizing the waste heat by an air preheater would mean another temperature increase with no material to stand it.

It follows that Mr. Malone's invention cannot in its actual state be of great importance in power-plant practice. Although the performance of a motor may be improved by it, it must be remembered that the motor is only one part of a system, the other components of which must be modified accordingly. This has not been done up to the present.

MAX WÜLFINGHOF.

Erfurt, Germany.

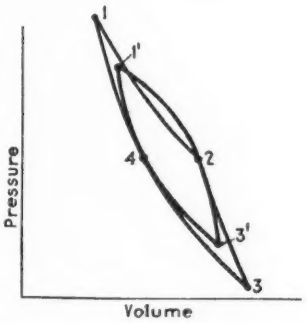


Fig. 2 (Left)—Pressure-volume diagram of Malone cycle (1'-2'-3'-4') compared with that of Carnot gas cycle (1-2-3-4)

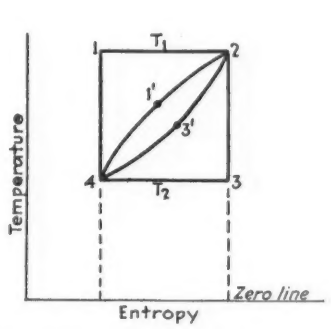


Fig. 3 (Right)—Temperature-entropy diagram corresponding to Fig. 2

READERS' PROBLEMS

ONE CO_2 MACHINE FOR TWO BOILERS—*How can we install a single CO_2 machine for two boilers so as to be able to use the machine on either boiler?*

R.B.O.

This can easily be done by bringing a sampling connection from the gas outlet of each of the boilers down to the inlet connection of the CO_2 machine. Valves should be placed in each of these two lines as close to the machine as is practically possible so as to allow the shutting off of the sample line connected to the temporarily dead boiler while the sample line from the operating boiler is open to the machine.

Care should be taken to avoid clogging of the end of these sample lines in the boiler with dust and soot. This can be accomplished by using a 1- or 1½-in. pipe at the point of entrance into the boiler, so connected with a tee that this short piece of inch pipe can be poked clean with a rod or blown with an air hose. A pipe plug screwed in the open end of the tee and shellacked over will avoid air leakage at this point.

The line running from the tee to the machine does not need to be so large. In fact, less lag between changes in CO_2 at the point of sampling and their registry on the machine will be obtained if ⅛-in. seamless copper tubing is used for this connecting line.

BURNING COKE BREEZE—*Is it possible to burn coke breeze on underfeed stokers? How is the efficiency and stoker maintenance? Is there any limit as to the size of the particle? Can it be burned in a pulverized-coal furnace?*

H.A.N

Coke breeze cannot be burned successfully on underfeed stokers, nor is it desirable to burn it in pulverized form, because of the abrasiveness of the coke, which causes excessive wear on the stoker rams or the pulverizer parts. It can be burned successfully, however, on chain-grate stokers or on hand-fired grates, the plates of which should contain numerous holes sufficiently small to prevent siftings through them but adequate in number to permit the passage of sufficient air for combustion. Front and rear arches are desirable to assist combustion.

The coke should be of uniform size. If there is a wide variation in size the coarse particles offer less resistance to the flow of air and require thicker fuel bed. Moreover, the fines will burn first and the coarse particles will be dumped in a partially burned state. If the bulk of the coke is too fine, a strong draft will carry some of it up the stack. Coke breeze that will pass through ¾-in. screen and about 25 per cent of which will be caught on a ½-in. screen, 40 to 50 per cent on a ¼-in. and the remainder on a ⅛-in. screen, seems to give the most satisfactory results.

The depth of fuel bed for such sizes should be from 6 to 7 in., although a slightly thicker or thinner fuel bed may give good results under certain conditions. The grate speed should be between 4 and 10 in. per minute, depending upon the rate of driving the boiler.

A slightly negative pressure in the furnace is desirable (0.03 to 0.05 in. of water) and the forced draft in the windbox will run up to a maximum of 3 in. of water, depending, of course, on the thickness of the fuel bed.

Stoker maintenance with coke breeze is likely to be higher than with bituminous coal, due to the abrasiveness of the coke, which works down into the moving parts.

Efficiencies comparable with those obtainable with bituminous coal are possible. The heat value of the coke will run from 11,000 to 12,500 B.t.u. as fired.

▼ ▼ ▼

Coils May Be Cut Out of Induction-Motor Windings

Summary of Readers' Opinions on the Previous Question

WHEN A COIL fails in a three-phase induction motor's winding can the coil be cut out of circuit and the winding closed as in a direct-current armature? If a coil is cut out of one phase will it be advisable to cut a similarly located coil out of the other two windings? If coils can be cut out of the winding how many can be eliminated before the motor operation will be affected adversely? E.H.C.

IN THE many answers received it is generally agreed that coils can be cut out of induction-motor windings. The number that can be cut out without seriously affecting the motor's operation will depend upon conditions. Several cases are cited where motors have been and are operating with one or more coils cut out of one or more phases. There is a disagreement in the answers as to the advisability of attempting to keep the number of coils in the different phases equal. For example, if one coil is cut out of one phase of a three-phase motor, should a coil be cut out of the other two phases to balance the winding? Apparently both practices are followed.

One point not covered by any of the answers to the question is the effects of the motor's terminal voltage on the problem. For instance, if one motor was operating on 10 per cent overvoltage and another on 10 per cent undervoltage the effects of cutting coils out of the windings would be quite different. In the motor on low voltage, cutting out coils in all three phases to reduce the number of turns 10 per cent would have the effect of making the winding suitable for the voltage on which it was operating, although the horsepower of the motor is reduced. On the other hand, cutting out 10 per cent of the coils in a motor that is operating on 10 per cent overvoltage leaves the motor operating under conditions of 90 per cent windings and 110 per cent volts. This is equivalent to 22 per cent overvoltage on the winding, a condition under which the motor could not be expected to operate. Several of the replies that are typical of those received are given in the following.

* * *

COILS can be cut out of three-phase induction motor windings, but the type of winding determines to a great extent the method to use. For example, with a two-layer lap winding one or more coils can be cut out. The defective coils should be cut in two at the end turns and the coil terminals bridged. With two-layer wave windings a long jumper must be used to connect the top and bottom leads of the coils, which are about one pole pitch apart. As wave-winding coils are generally open-end, it is not necessary to cut the coil open.

In a one-coil-per-slot winding of the concentric chain type, one coil per pole-phase group may in some cases be cut out. With any type of one-coil-per-slot winding it is always safer to thread in a coil at once to replace the defective one.

The reason for this distinction is that with one coil per slot the turns per phase are concentrated in a few coils and the phase angle between slots is greater; thus the effect of cutting out one coil is greater than in the wave or lap windings. These conditions also

apply to the basket-type winding. A safe rule to follow is to replace all defective coils at once in one-coil-per-slot machines by threading in new ones. One to three turns may be omitted if it becomes difficult to get them through the slots.

On some of the larger machines cutting out coils may cause shaft currents and a bearing may be destroyed before the trouble is discovered. Anything that affects the magnetic circuit, such as a motor operating on unbalanced voltage, may start shaft currents.

Ordinarily one coil can be cut out of one phase only without causing trouble. I know of a 100-hp. slow-speed motor with a seven-parallel delta-connected winding that operated with four coils cut out of one phase. The design and service conditions greatly affect the motor's operation when coils are cut out. For example, a two-parallel connection with equalizer connections might operate satisfactorily with two or three coils cut out of one pole-phase group.

Regarding the number of coils that may be cut out, a safe rule is: do not cut out more coils than would cause the motor to operate on 10 per cent overvoltage. Thus it should be possible to cut out coils per phase up to 10 per cent of the total turns per phase and cut out a like number in each phase to balance the winding, if the operation does not result in more than a 10 per cent overvoltage condition.

Coils should be cut out only when necessary to keep equipment in service, and proper repairs should be made as soon as conditions permit. As it is seldom that one or more coils fail without weakening the rest of the winding to some extent, in most cases patching winding becomes a continuous performance and an expensive one.

Wilkensburg, Pa. A. C. Roe.

After one coil of a three-phase induction motor winding fails, it can be cut out of the circuit and the winding closed without it. The result is that there will be a slight unbalance of phase currents in the motor, but not enough to cause improper operation. Under this condition of operation there will be two weak spots in the motor field where the sides of the faulty coil are located.

The phase currents can be balanced by cutting out similarly located coils in the other two phases, thereby giving approximately equal impedances on all three. This will be undesirable, because the number of weak spots in the field will be increased from two to six and the power delivered by the motor will be materially decreased.

If more than two or three adjacent coils are eliminated in this manner, its efficient operation will be impaired. I have known cases where several coils were cut out of a large slow-speed motor and operation continued. This was done as an emergency measure, however, and the faulty coils were repaired at the first opportunity. Operation under these conditions is not recommended, because of extra heating in the remaining coils and uneven distribution of the stator magnetic field.

Ashland, Ky.

E. W. MacCorkle, Jr.,
Power Engineer,
K. & W. Va. Power Co.

Cutting out defective coils in a three-phase motor is frequently an easy way to keep a defective motor running. In many cases motors so treated have continued to give good service for years. The best way to do the job is to cut the defective coil in two and tape up the cut ends, then make the correct connections between the two coils on each side of the defective one.

There is usually no need to attempt to balance the circuit by cutting out coils in the other phases. On a motor with 72 slots I have seen as high as two or three coils cut out of each phase. Due to the new improved types of electric motors, cutting out coils is likely to rapidly disappear from the engineer's bag of kinks. Most of the trouble on any equipment comes from dirt, grit and oil, and so I favor the ball-bearing, fan-ventilated motors.

Denver, Colo. Carl A. Wagner.

It is entirely practical to cut out defective coils in induction motors; it is done quite often. Sometimes a coil will fail, and by cutting it out at once the motor can be kept in service with but little delay. Of course, this is more or less of an emergency measure, but it has prevented long production delays. As many as 10 per cent of a phase group can be cut out if necessary, but this is not advisable except when a spare motor is not available.

A Question for Our Readers

IT HAS always been a serious problem in our plant to prevent the three-phase motors operating single-phase. These motors are in many cases protected by fuses only. In one instance a fuse blew on a feeder supplying several motors and they operated single-phase for some time before the fault was detected. In this case it was possible to stop part of the motors and start them again, since the running motors on the feeder acted as phase converters to supply three-phase power for starting. I should like to hear how other operating engineers are handling this problem and what they consider the best way to check the fuses.

E.C.M.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

When cutting out a coil it is best to cut the defective coil in two so that it will not heat from induction. I always do this with a hacksaw at each end of the coil. At present I have two coils cut out in a 50-hp., 600-r.p.m., 2,200-volt motor that is operating a resaw in our planing mill and have experienced no trouble from heating. The coils have been cut out for nearly two years. I lifted coils and put in some new ones, but they fit so tightly and were so hard to get up that I decided that less trouble would be had if the winding was let alone. Of course it is quite probable that we will have to rewind the motor at some time, but so far it is O. K. I do not think it either necessary or advisable to cut out coils in the other sections of the windings.

Westfir, Ore.

W. G. Cummings,
Chief Electrician,
Western Lumber Co.

If a coil is cut out of one phase, it is advisable to cut a similarly located coil out of the other two windings. This balancing should certainly be done if two or more coils are cut out. A convenient rule for the repair man is to cut out coils evenly distributed around the stator; that is, in a 96-coil winding the 33d and the 65th coils, counted from the defective coils as No. 1, should be cut out.

It may be said that the motor's operation will be affected adversely by removing one coil per phase. The cutting out of a coil has the effect of increasing the voltage per coil on the remaining coils in the same phase. This, of course, causes heating and reduces the maximum possible load that the motor can drive. Since few induction motors, other than those driving fans and pumps, run at full load continuously no hard and fast rule can be laid down for the number of coils that may be cut out and still allow the motor to operate reasonably satisfactorily. I know of a 96-coil motor running for several days with seven coils cut out, where no attempt was made to balance up the phases. Cutting coils out of a winding is a makeshift; the proper repairs should be made as soon as possible.

Coraopolis, Pa. M. A. Powell.

A coil can be cut out of a three-phase induction motor and the winding closed, if properly done. Be sure to cut the damaged coil in two so as to break the circuit through this coil. Connect the remaining coils in the damaged group so as to complete the circuit. In most industrial motors you can cut out as many as three coils without affecting the operation very much. I have several motors running at present with two and others with three coils cut out. It is not necessary to cut coils out of the other two phases to balance the motor.

St. Louis, Mo. Ed. Killough.

Rectifiers Compared With Rotary Converters*

By C. M. WARD
Superintendent of Operation
Milwaukee Electric Railway & Light Co.

Data are presented from operating records of three automatic mercury-arc and two automatic rotary converter substations of comparable size and operating under similar conditions for a three-year period.

THE Milwaukee Electric Railway & Light Company has in service three 550-kw., 600-volt, fully automatic mercury-arc rectifier, single-unit substations, each having a guaranteed overload rating of 25 per cent for one-half hour; 50 per cent for 3 min.; and 100 per cent for one-half minute. These substations were placed in service in 1927 and supply energy to a section of an interurban line. There is also in operation on the Milwaukee system a number of fully automatic 500-kw., 600-volt rotary-converter substations supplying similar service. These stations were placed in service early in 1928. Some of the synchronous converters are guaranteed to carry momentary overloads of 100 per cent and others 200 per cent without injury. Each of them has a 50 per cent overload rating for 2 hours.

Records concerning service availability of both rectifier and converters have been maintained since the different stations were put in service; however, these data alone were of little value in preparing operating expenses for the different types of converting equipment. Since such a comparison appeared advisable, a special accounting procedure for collecting the necessary data was initiated about 18 mo. after the rectifier installations were completed. In a majority of automatic equipment installations, our records indicate that more faults developed in the first year's operation than in any succeeding 12-mo. period. The operating expense of the rectifier substations for the first year is not included in the figures, the reason being that it is not available. The cost figures for the first six months of operation for the rotary converter stations also are not available. Therefore delays resulting from minor faults appearing during starting periods are not included in either case. It is believed that the comparison is a fair one and the results obtained are fairly accurate in indicating the reliability of service, as well as operating expense of small substations converting 60-cycle alternating-current to 600-volt direct-current energy.

By far the most prevalent cause of failures in rectifier substations resulted from ignition or excitation faults. This nearly always caused a burnout of either or both the ignition and excitation relay coils. On the units under consideration, it is necessary to open the tube tank with corresponding loss of vacuum in order to replace ignition-rod springs which were almost invariably annealed when the ignition coils failed. This operation necessitates keeping the unit out of service for at least 24 hr. in order to re-establish a satisfactory vacuum within the tube tank.

After considerable study, it was learned that under certain conditions during starting periods, the ignition anode becomes a cathode, which establishes a circuit through the excitation coils to the trolley. With this circuit completed, the excitation coil soon burns out, thus energizing the ignition coil continuously and this coil is then over-heated to failure within a few minutes. To overcome this difficulty, the control wiring was changed to prevent closing the direct-current circuit breaker and the high-tension oil circuit breaker until after excitation is established. As stated previously, ignition and excitation troubles were the cause of the great majority of service outages before the change in control wiring was made, early in 1930. This source of trouble has been eliminated by the present system of the wiring. No coils have been burned out, in either the excitation or ignition relays, and no ignition-rod-spring trouble experienced, since the change was made.

The curve show the average operating expense of the two types of stations under discussion. The solid line refers to rotary-converter and the dash line to mercury-arc-rectifier stations. Figures given as dollars per month are 12-mo. average, with the exception of the first 5 mo. of 1929, previous 12-mo. data not being available. January, 1929, is a 7-mo. average; February, 8-mo.; March, 9-mo.; April, 10-mo.; and May, 11-mo. average. The rise in operating expenses of rectifier stations to a value of approximately $112.00 per month in April, 1930, and the subsequent drop

TABLE I — ROTARY-CONVERTER SERVICE FAILURES

Station	Year[1]	Number of Failures	Time Not Available for Service Hr.	Min.	Average Outage per Failure Hr.	Min.
Chamberlain[2]	1929	2	7	50	3	55
Wind Lake[3]	1929	2	5	30	2	45
Chamberlain	1930	5	14	25	2	53
Wind Lake	1930	7	19	45	2	50
Chamberlain	1931	1	2	..	2	..
Wind Lake	1931	1	1	..	1	..
Both	1929	4	13	20	3	20
Both	1930	12	34	10	2	51
Both	1931	2	3	..	1	30
Both	1929 to 1931, inc.	18	50	30	2	48
Average number of failures per station per year						3
Average time station is not available for service per year					8 hr., 25 min.	
Average length of outage per failure					2 hr., 48 min.	

[1] Year 1929 includes November and December of 1928, in addition to all of 1929. Year 1931 does not include November and December of 1931.
[2] Chamberlain rotary has 200 per cent momentary overload rating.
[3] Wind Lake rotary has 100 per cent momentary overload rating.

*Abstract from a paper "Mercury-Arc-Rectifier Versus Rotary-Converter Automatic Substations," presented at the Great Lakes district meeting of the American Institute of Electrical Engineers, held in Milwaukee, Wis., March 14 to 16, 1932.

TABLE II — MERCURY-ARC RECTIFIER SERVICE FAILURES

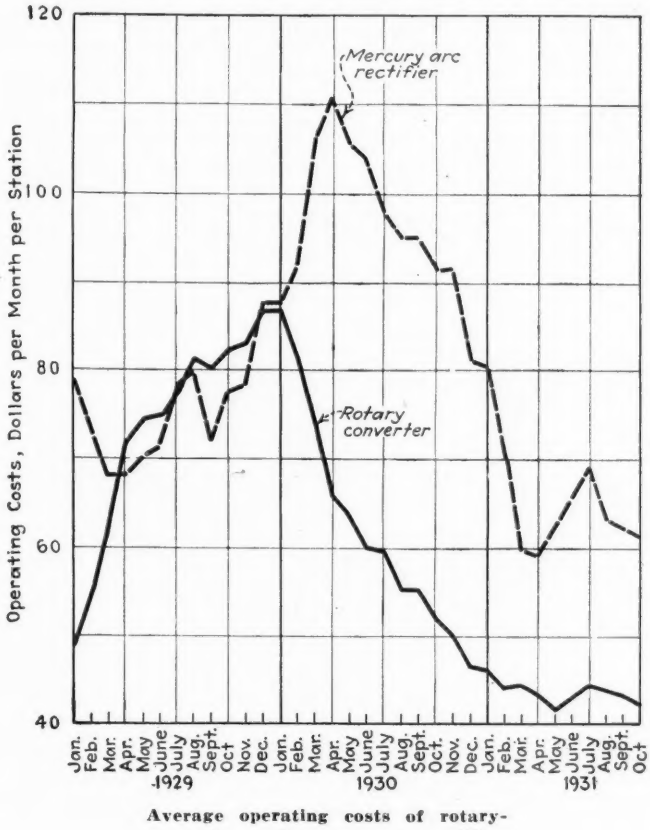
Station	Year[1]	Number of Failures	Time Not Available for Service Hr.	Time Not Available for Service Min.	Average Outage per Failure Hr.	Average Outage per Failure Min.
Nemahbin	1929	17	758	43	44	38
Oconomowoc	1929	8	121	20	15	10
Pipersville	1929	3	82	50	27	37
Nemahbin	1930	2	1	14	..	37
Oconomowoc	1930	4	59	20	14	50
Pipersville	1930	6	260	15	43	22
Nemahbin	1931	1	1	18	1	18
Oconomowoc	1931	5	4	6	..	49
Pipersville	1931	3	25	44	8	35
All	1929	28	962	53	34	23
All	1930	12	320	49	26	44
All	1931	9	31	8	3	28
All	1929 to 1931, inc.	49	1,314	50	26	50
Average number of failures per station per year						5.4
Average time station is not available for service per year					146 hr.,	5 min.
Average length of outage per failure					26 hr.,	50 min.

[1] Year 1929 includes November and December 1928 in addition to all of 1929.
Year 1931 does not include November and December 1931.

is explained by the ignition and excitation troubles previously referred to, and which was corrected early in 1930. The increase during 1929 in synchronous-converter operating expenses is the result of direct-current riser troubles in one machine and shunt-field failures in the other machine.

Table I summarizes rotary-converter failures, and Table II contains similar information on the three mercury-arc rectifiers. It will be noted that the average time per year a rectifier is not available for service is approximately 18 times greater than the non-available time of rotary-converter stations during this 3-yr. period. However, a great improvement in service availability of rectifiers was effected when the ignition and excitation troubles were corrected in 1930, and this improvement is clearly indicated in the 1931 record when the average number of failures dropped from a previous 2-yr. average of 6.6 failures per unit per year to an average of 3 failures per unit in 1931. The hours outage improvement during 1931 as compared with the two previous years is much more impressive during 1929 and 1930, the annual service outage per station amounted to 213 hr. and 57 min., while in 1931 this figure dropped to 3 hr. and 28 min. The improvement, pronounced as it is, still leaves rectifier troubles and outages above the 1931 record of synchronous-converter stations.

Rectifiers are more efficient than synchronous-converter units, but no material saving is effected in 500-kw. stations supplying energy for interurban systems where the average output is somewhere between 40,000 and 50,000 kw.-hr. per mo. per station. It is, therefore, apparent that the cost of energy saved by reason of the more efficient converting equipment will just about amount to the difference in operating cost, given on the curves for 1931.


120
100
80
60
40
Operating Costs, Dollars per Month per Station
Mercury arc rectifier
Rotary converter
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct
1929
1930
1931

Average operating costs of rotary-converter and mercury-arc rectifiers

No complaints of interference with telephone circuits or radio have been received since the rectifiers were put in service. An experimental line parallelling the trolley supplied by these rectifier stations was installed by the local Bell telephone company a few months after the substations were installed. The results indicated that there would be no trouble from this source.

In arriving at conclusions after comparing operating records of rectifier and synchronous converters covering a 3-yr. period, it is unfair to neglect the fact that these rectifier stations were the first, or if not the first, one of the earliest installations with full automatic control in unattended substations. Full automatic rotary control stations had been in service many years. Therefore, the 1931 record may be assumed to be more indicative of normal performance. Proceeding under this assumption, the records indicate that under conditions of operation existing in the Milwaukee interurban territory:

1. There is practically no difference in operation and maintenance costs of the two types of converting equipment, taking into consideration the higher efficiency of rectifiers.

2. Service availability of converters is slightly higher than service availability of rectifiers when the converting equipment is unattended and equipped with automatic control.

3. Control system failures in whole or in part are vastly more serious in automatic than in manually controlled stations.

4. More attention should be given to auxiliary relays, operating coils, protective equipment, etc., used in automatic control systems, to insure against faults in them.

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New Equipment Installed in McGill Hydraulic Laboratory

THE HYDRAULIC LABORATORY at McGill University, Montreal, has been greatly enlarged and new equipment has been added, including an experimental turbine with interchangeable runners of the latest types, centrifugal pumps, an experimental pipe line and other improvements. It is now possible to provide for graduate research investigations where flows of water not greater than 10 cu.ft. per second are required; this flow is obtained by recirculating the water through the laboratory pumps.

The engineers of the Back River power development at Montreal used the hydraulic laboratory facilities in making a study of certain problems of that undertaking, and later constructed a small section of the dam at the plant to provide for hydraulic experiments involving the use of much larger quantities of water than are available in the laboratory. The Fraser Brace Company, Ltd., likewise used the improved facilities of the hydraulic laboratory in connection with one of its projects.

Improving Weather-Resistant Wire Coverings

AT THE insistence of the engineers in the companies represented by the Utilities Research Commission, that weather-resistant wire coverings should be developed to provide longer life and higher insulating values, the commission initiated a study of this problem at Purdue University. This study of the Utilities Research Commission was started Oct. 1, 1929, under the direction of the Electrical Division of the Engineering Experiment Station with the Chemical Division cooperating. The results of the work done so far was given in a paper "Weather-Resistant Covering for Line Wires," by C. F. Harding, L. L. Carter and J. W. Olson, presented at the Great Lakes Meeting of the American Institute of Electrical Engineers, Milwaukee, Wis., March 14 to 16, 1932.

The work at Purdue University indicates positively that the poor physical properties of the saturants used in weather-resistant wire coverings in the past have been the cause of the extremely early failure of weather-resistant wire. The coverings of wires which last well are eventually caused to fail by a combination of physical changes, by the saturants shifting in the coverings, and chemical changes in the saturant caused by exposure to light, oxygen of the air, etc. In very early failures the effects of light and oxygen are of less importance than the effects of poor physical properties, which cause the saturant to shift in the braid when hot and to crack and split when cold.

These poor physical properties of the saturants are, namely, too-low fusing points, extreme softness when warm, great changes in hardness with changes in temperature, extreme brittleness at even moderately low temperatures, and a marked tendency to evaporate. The majority of saturants used have had softening points (as determined by the ball-and-ring method) ranging from 130 to 150 deg. F., lower than maximum wire operating temperatures. These materials shift in the braids, leaving the upper braids unprotected at ordinary summer temperatures, which are well below the fusing point. The extreme brittleness of these saturants, which results in cracking and breaking of the braids in cold weather, may be illustrated by the fact that less than two degrees bending is required to break molds of these saturants in the pliability test at zero deg. F.

Many of the poor physical properties, particularly the disappearance or evaporation of the saturant from the braids, have been caused by the addition of excessive amount of waxes, wax tailings or low-melting fluxes to obtain fluidity and ease of saturation. This addition was usually made by the workman operating the saturating tank and resulted in a saturant of variable properties. These low boiling materials soon leave the saturant causing the body of the asphalt to disintegrate. The saturants vary in their resistance to the weathering effects of light and oxygen and the worst are subject to excessive surface deterioration and erosion.

The result of all these factors is the loss of compound, particularly from the upper side of the braids, with the resultant breaking of the braids on the upper side and the familiar festooning.

The use of materials subject to such faults has been permitted by specifications which did not specify the source or physical properties of saturants. Proper specifications have not been written because of a lack of knowledge essential to the writing of such specifications. The work at Purdue University is to provide such a specification.

The commonly used drip and stain tests cannot be regarded as tests of the physical properties of the saturants. The high-melting wax used as an outer coating prevents staining and the yarns hold the asphalt, preventing dripping, even though the saturant may be quite soft. The drip test may also favor an under-saturated braid.

Finishing waxes cannot be regarded as of great protection to the covering, because they evaporate or crack and flake off within a short time or are damaged in installation. The wax has cracked, chipped off, or simply disappeared from the surface of the wire, on the various samples in the natural exposure rack tests, in from three to eight months.

New and Different Types of Coverings

While the development work carried on thus far has been concentrated upon providing an improved asphaltic-base saturant which could be applied to the present triple-braid covering without great changes in the weather-resistant wire plant, experimental work with other types of weather-resistant saturants and with coverings other than triple braid has been carried on.

Bakelite and other synthetic resins, Harvel compounds and varnishes and other materials have been applied to weather-resistant wire coverings. The use of these materials as saturants for a single outer braid, applied over an insulating cover on the conductor, provides a highly protective coating because of the excellent weathering quality of such materials.

Experiments with conductors having a paper-tape covering next to the conductor and a single outer-braid weatherproofed with these very high quality saturants have shown that covering of consistently high insulating value can be obtained and that the paper next to the conductor does not deteriorate appreciably in the time of one accelerated weathering test.

Most of these high-grade saturants can only be applied to one braid because of their high cost.

It is expected that future work will provide a weather-resistant wire covering of higher insulating value and longer life than the present triple braid construction but of smaller size and weight. There are many interesting possibilities of improvement in this type of covering.

Conclusion

The present triple-braid weather-resistant wire covering may be materially improved by the use of higher fusing-point blown asphalts, free of waxes and low boiling fluxes, as saturants. Such a saturant will provide a covering of uniformly long life.

It has been proved that the higher saturating temperatures required to apply such saturants may be used without damage to the cotton yarns or excessive annealing of the copper conductors.

Specifications for weather-resistant coverings will soon be written as a result of this work, the terms of which will guarantee to the utility, weather-resistant wire of long life.

Future work will provide a covering of lighter weight and smaller size but of higher insulating value and longer life than present construction.

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Moscow Fifth in Central Heating

Moscow stands fifth among all cities in the world in centralized heating. The development of the centralized heating system foreseen for the next three years will place Moscow in the foremost place in this respect.

According to a general plan, Moscow's centralized heating system will give, by 1937, 80 per cent of all the heat required by that city. At present it covers only 5 per cent of the heating. The centralized heating system is to be combined with the city's power system, as from the point of view of technique and cost the combined heat and power production is most efficient.

Only 20 per cent of fuel is being utilized under the present method of operation. Under the combined centralized heating and power system it will be possible to utilize 60 per cent of the fuel.

Coal from the Moscow district is to be used as the principal fuel. So far only 3 per cent of local coal is used in the heating of Moscow, 78 per cent of the fuel used is Dones coal and oil. The plan provides that 87 per cent of all fuel used in Moscow shall consist of Moscow coal.

Energetic measures are taken to build the equipment necessary for a centralized heating system in Moscow.

WHAT'S NEW IN PLANT EQUIPMENT

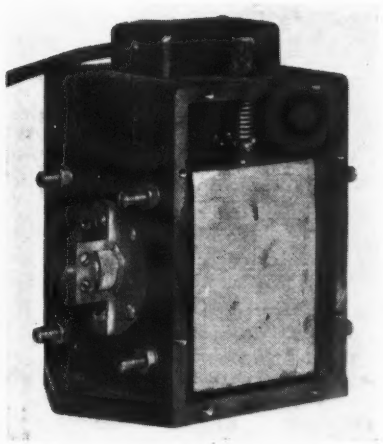
Miniature Seismograph Measures Vibration

SOMEWHAT LIKE the seismograph, a device for recording earthquake tremors, is the instrument developed in the general engineering laboratory of the General Electric Company, Schenectady, N. Y., for the measurement, in thousandths of an inch, of vibrations in steam turbines or other machinery to which the instrument is attached.

Within its case, which is bolted to the machine under investigation, there is suspended a block of lead. Two tension springs on the top and four springs on each side of the weight hold it in position. The outside shell of the detector vibrates at the same period as does the machine to which it is attached, but the lead weight, because of its mass and low natural frequency, remains fixed in space.

In the lead weight are embedded two coils, on opposite sides. In front of each coil is an adjustable piece of magnetic steel, fastened to the outer shell. The coils in the weight are energized by 500-cycle alternating current, and the air gaps between the coils and pieces of magnetic steel are adjusted so that the two coils are electrically balanced—the amount of current through the coils depending on the distance of the steel pieces from them. There is, then, a zero reading of the indicating instrument when there is no vibration.

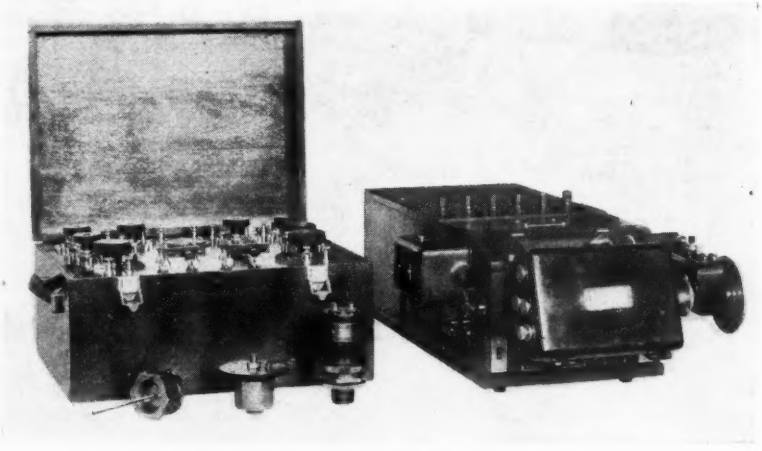
Vibrations of the machinery to which the detector is attached cause a swaying of the outer shell of the instrument, and therefore varying distances between the coils and the magnetic pieces. These differences cause a variation in the flow of the 500-cycle current—differences that, in the indicating or record-instrument, are accurately translated into readings of vibration amplitudes in thousandths of an inch.



Vibration detector. End removed to show suspended lead weight

Somewhat similar to the device already described is a pressure detector also developed in the general engineering laboratory. A small case enclosing one such coil, and with the magnetic piece as a diaphragm just beyond it, is arranged so that it may be screwed to the vessel containing the gas or liquid whose pressure is to be measured. A similar unit is used as a dummy for the calibration of the circuit.

Variations in pressure cause movements of the magnetic diaphragm and therefore changes in the readings of the instrument. Low-pressure changes are transmitted to the diaphragm direct for measurement; higher pressures, up to 2,000 lb. per sq.in., are recorded by the use of cylinders and pistons.



Electric micrometer, vibration and pressure test units on left; oscillograph on right

Lightning Arresters Go Inside of Transformers

ALMOST complete immunity from lightning failures and a reduction of fuse blowing, as well as a lowering of installation cost, have been accomplished in a new method of interconnection of distribution transformers and lightning arresters. Radical departures have been incorporated in the design of the lightning arresters, which are suspended inside the transformer tanks, as in the figure.

The arresters are connected to the incoming high-voltage lead and the grounded lead on the low-voltage side, the usual ground connection for arresters being omitted. They can be installed in modern pole-mounted transformers without change; steel transformer tanks fabricated within the past two years or more have been designed with this in mind.

Thyrite lightning arresters *A* mounted inside of transformer tank

The arresters, completely assembled and especially designed for this application, are being produced for 2,400- and 4,800-volt service by the General Electric Company, Schenectady, N. Y. They are of Thyrite, a material that is both a good insulator and a good conductor of electricity.

Thyrite has the property of changing its resistance as the voltage is changed. Each time the applied voltage is doubled the resistance decreases, so that the current is increased more than twelve times. If the voltage is increased 16 times, the current is increased more than 25,000 times. Its resistance changes as quickly as does the applied voltage; the resistance can be decreased to a millionth of its original value in a short time, such as a millionth of a second. The material, then, is a good insulator with the transformer voltages, but is a good conductor for the discharge of lightning or voltage surges.

THE ENGINEER'S

An Engineer's View

PATHWAYS BACK TO PROSPERITY. *By Charles Whiting Baker, C.E. Published by the Funk & Wagnalls Company, 354 Fourth Ave., New York City; 1932. Cloth, 6x9 in.; 351 pages. Price $2.50.*

THE PRESENT PERIOD has given rise to numerous writings on our economic ills and their solution. Some are couched in terms little understood by the average man, whereas others prescribe radical measures not readily applicable to our existing system. Nearly all point to the inadequacy of the orthodox theories of economists to cope with the situation.

The author of this book is a well-known engineer. His analysis of the depression is searching and basic. His suggestions are constructive and progressive without being radical in the sense that they would upset our present system.

"The Wall Street collapse did not cause the depression," says Mr. Baker, "but it did change public sentiment from extreme optimism to pessimism. We were headed for the depression long before the Wall Street crash. While part of the fall in security prices has been due to collapse of speculation and fictitious values the major part has resulted from actual reduction in earnings."

Among the several factors responsible, the mechanization of industry assumes the major role. Not that this could or should have been prevented, nor that it will not be carried further, but it has thrown our employment out of balance as well as our production and consumption capacities. Our machinery for the production of wealth has been perfected but that for the distribution of wealth has broken down. Under our social machine too large a portion of the earnings of industry has gone to the few who have their wants well supplied and the surplus has been invested in further productive capacity beyond the ability of the public to absorb.

Big business was not content with supplying normal demands but set out, through high-pressure sales effort, to create a demand which through the application of installment buying used up normal demands of two years in advance. Markets were filled to the saturation point and future business was mortgaged for the sake of current profits.

The author is of the opinion that production on a very large scale does not always mean the lowest costs and that industries of moderate size can often compete at a profit when the big producer runs at a loss. Huge industrial combinations have brought neither benefit to the public nor profit to themselves.

Finally, there is too much concentration within the large cities which tends to continued increase of increment land values, that in turn are a burden on production costs.

Among Mr. Baker's suggestions as pathways back to prosperity are:

1. Restoration of confidence.
2. Better organization of our banking system.
3. Transfer to the wage earner of a larger share of the profits of industry to increase purchasing power rather than have these profits find their way into investments for still further increasing production.
4. Shorter working hours to assist employment.
5. State insurance in place of charity.
6. Economy to replace extravagance.
7. Tax on luxuries, especially on wine and beer to do away with the huge profits of bootlegging which mean no return to the Government.
8. Decentralization of industry away from the large cities.

The book is well worth careful reading.

Our Coal Economy

THE COMPETITIVE POSITION OF COAL IN THE UNITED STATES. *A study published by the National Industrial Conference Board, Inc., 247 Park Ave., New York City; 1932. Cloth, 6x9 in.; 288 pages; tables, charts and maps. Price, $3.*

IN 1930 the United States produced nearly 532 million tons of coal, 898 million barrels of oil and 1,943 billion cubic feet of natural gas. The vastness of the sums involved indicates the tremendous importance of these energy sources to our industrial era.

Coal, both anthracite and bituminous, has supplied a major part of this energy, the quantities used growing rapidly from about 280 million tons in 1900 to a peak of about 650 million tons in 1918. In spite of continued industrial growth this peak has not been equaled since, due to a number of factors whose extent and mounting trends are exhaustively studied in the present volume.

Anthracite, as an energy source, has consistently decreased in per cent of the total energy consumption supplied. Bituminous coal, on the other hand, has slowly risen, reaching a peak in 1909 of 86 per cent of the total energy consumption but dropping to 61 per cent in 1930.

This decreasing importance of bituminous coal in the face of rising industrial activity has been traced, in the main, to three major factors, namely, excess productive capacity, increasing competition from other energy forms and growing efficiency in fuel utilization. The third factor has been the most important and has grown rapidly in effect since 1920.

This volume, in three main parts, is devoted to an exhaustive study of the position of the coal industry in the United States. Part I gives a general survey of the place of the United States in the world coal industry, of the changes in regional output and the relationship of competitive factors to total energy demand. It includes the first two chapters.

Part II, dealing with coal consumption by major uses and consumer groups, studies the losses or gains in the use of coal and where they have occurred. This part, consisting of six chapters and amply illustrated with charts and tables, is particularly interesting since it analyzes the consumer market. American coal producers are in a position to determine the amount of coal mined and shipped. A better knowledge of ultimate destination and of use, however, is essential to analyses of market possibilities.

Part III, likewise of major interest, deals with coal demand by regions and the trend of competition betweeen producing fields. This part, consisting of four chapters, is in many respects the reverse of the picture given in Part II.

Part IV takes up the competitive relationship of the anthracite and bituminous coal industries in the United States. It discusses the economic problems with which both are faced and indicates possible solutions for their manifold difficulties.

Metals at High Temperatures

SYMPOSIUM ON THE EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS. *Published jointly by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., and the American Society of Mechanical Engineers, 29 West 39th St., New York City; 1932. Cloth, 6x9 in.; 825 pages. Price, $6.*

FULL PROCEEDINGS of the joint A.S.M.E.-A.S.T.M. smyposium on the effect of temperature on metals, which was reported in abstract in *Power* for July 7, 1931, are contained in this volume. They comprise 27 papers by 38 authors, covering data on metals used in power plants, the chemical industries, oil refining, smelting and the automotive industry. In addition, the written discussions of other engineers and metallurgists are included.

The book is divided into two general sections, one dealing with engineer-

BOOKSHELF

ing trends and requirements for metals at high and low temperatures, the other with the properties of available metals for such services. Papers on the individual subjects contain not only a summary and critical appraisal of the extensive foreign and domestic information already published, but include also much new material. Detailed indices and a comprehensive bibliography make the book a convenient reference volume, while a specially prepared introduction traces the history of events leading to the symposium and summarizes the more important points contained in the papers.

D. C. Armature Rewinding

REWINDING DATA FOR DIRECT-CURRENT ARMATURES. *By G. A. Van Brunt and A. C. Roe. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Cloth, 6x9 in.; 212 pages, 176 illustrations and 15 tables. Price, $2.50.*

FREQUENTLY armature winders find themselves in difficulty when rewinding or repairing an armature because they did not obtain proper data from the old winding before taking it off the core. Again, when the necessary data have been taken they often are not properly recorded so as to be used intelligently. Collection and use of rewinding data requires both a sound knowledge of the different types of windings used in direct-current armatures and an understanding of the principles governing the layout and connections of coils.

A practical treatise, this book gives directions for taking and recording in a uniform and systematic manner the necessary data to give a specification of an armature winding so that it may be reproduced by a winder with a reasonable amount of experience. The work is divided into 25 chapters of which five are on forms for recording data from different type of armatures, winding rules and marking armatures; two chapters give data on windings; four chapters are devoted to frog-leg windings; nine chapters deal with rewinding materials and how to use them. Other chapters cover subjects pertinent to a broad general understanding of direct-current armatures.

The book is written by practical men with a broad general knowledge of their subject gained from many years of experience. They have presented the material in a way that is easily comprehended by practical electrical workers, among whom the book should find a wide reader interest.

Public Plants in Nebraska

MUNICIPALLY OWNED ELECTRIC UTILITIES IN NEBRASKA. *By Paul Jerome Raver and Marion R. Sumner. Published by the Institute for Economic Research, 337 East Chicago Ave., Chicago, Ill.; 1932. Paper, 7½x10 in.; 61 pages, charts and tables. Price, $1.50.*

FOR THE PAST two years the Institute for Economic Research has been publishing studies on municipal ownership in this country. As the latest in the series, the present monograph presents a detailed analysis of conditions in Nebraska, which was selected for study, the authors explain, because of the comparatively large extent of the municipal ownership movement.

As in other states the trend of municipal ownership has been influenced principally by technical and legal factors, the latter governing the power of a community to own and operate an electric utility and the methods it may use to finance such an undertaking. In Nebraska all cities, villages and properly constituted power districts have the legal power to own and run power plants, and they may finance them by taxation, bond issues and payments from plant earnings. They are under the control of the State Railway Commission only in the matter of rates, security issues and rural lines.

Improvements in transmission technique and the development of more efficient prime movers have been the principal technical factors affecting public ownership. The authors state that the "rise and decline of municipal ownership in Nebraska has been a rise and decline in the number of generating establishments with a capacity of 100 hp. or less. Establishments with a capacity of more than 200 hp. have increased steadily in number since 1903, accompanied by a constantly increasing total horsepower capacity."

The study is replete with charts and statistics showing the changes in municipal ownership from 1886 to 1931.

BRIEF REVIEWS

THE ECONOMICS OF PUBLIC UTILITIES. Second Edition. By L. R. Nash. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 508 pages; price $4.—Thoroughly revised, this second edition includes much new material on political activities and agitations against public utilities, holding company control, natural gas movements, electric power transmission and statistical data.

POWER AND THE PUBLIC. Edited by Ernest Minor Patterson. Published by the American Academy of Political and Social Science, 3457 Walnut St., Philadelphia, Pa.; 190 pages; price $2.50, cloth, or $2, paper.—Full proceedings of the two-day meeting held last fall by the Academy on the subject of "Power and the Public." This meeting was reported in abstract in *Power* for Nov 17, 1931.

STANDARD CONSTRUCTION METHODS. Second Edition. By G. Underwood. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 501 pages, illustrated; price $5.—A manual of best methods in all phases of construction work for the use of superintendents and others upon whom rests the responsibility of getting construction jobs done quickly and efficiently. The second edition contains much new material.

MECHANISM OF COMBUSTION OF INDIVIDUAL PARTICLES OF SOLID FUELS. By David F. Smith and Austin Gudmundsen. Published as Bulletin 49, Carnegie Institute of Technology, Pittsburgh, Pa.; 23 pages, illustrated; price 25c.—Results of a study on the effect of particle size, air velocity, temperature and humidity on the rate of burning of carbon particles.

PART I: RELATIVE IGNITABILITY AND RELATIVE EASE OF PROPAGATION OF FLAME OF SUSPENSIONS OF POWDERED COAL AND SEMICOKE IN AIR; PART II: RATE OF BURNING OF INDIVIDUAL PARTICLES OF SOLID FUELS. Part I by H. K. Griffin, D. L. Reed and F. A. Hartgen; Part II by H. K. Griffin and J. R. Adams. Published as Bulletin 50, Carnegie Institute of Technology, Pittsburgh, Pa.; 85 pages, illustrated; price $1.—A description of recent research into some of the fundamental aspects of pulverized-fuel combustion, which has been conducted during the past four years at the Pittsburgh Experiment Station.

TECHNICAL PAPERS recently issued in printed form by the Institute of Fuel, 53 Victoria St., London, S.W.1, England, include: "The Properties of Coals as Determined by Their Mode of Origin," by George Hickling, and "The Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham. An interesting article on "Power Cost Accounts," by John Whitmore, appears in the October, 1931, issue of the *Journal of Accountancy*, while the Applied Mechanics section of the A.S.M.E. *Transactions*, for Jan. 30, 1932, contains a paper on "The Hydraulic Jump and Related Phenomena," by Boris A. Bakhmeteff.

NEWS of the FIELD

Program Announced for Annual Meeting of Welding Society in New York, April 27-29

A SYMPOSIUM on ductility in welds and various papers on welding pressure vessels and pipe are features of the program just announced for the annual meeting of the American Welding Society, to be held at the Engineering Societies Building in New York City on April 27, 28 and 29. Other features of the program include sessions on research, shipbuilding and structural steel, and special scientific demonstrations to be given at the annual dinner.

Papers by C. A. Adams, E. Chapman, E. R. Fish, C. J. Holslag, C. H. Jennings, H. F. Moore, D. Rosenthal and C. L. Waddell will be heard at the symposium on ductility in welds, which is scheduled for Thursday afternoon, April 28. It is expected that the symposium will crystallize opinions on this controversial subject and will correct many misconceptions about ductility of metals in general.

Among the topics to be covered on welding pressure equipment are: "Welding Wrought-Iron Pipe," James Aston; "Arc, Gas and Resistance Welding of Pressure Vessels," H. LeR. Whitney; "Welding of Steam Pipe," representative of United Engineers & Constructors, Inc.; and "Welding of Tube Turns," R. E. Fritsch. The first of these will be presented at the afternoon session on April 27, the second at the morning session on April 28 and the last two at the April 29 morning session.

Other papers include: "Experimental Determination of Stresses in Fillet Welds," L. C. Bibber; "A Study of the Transformation Points of Fusion Weld Metal," E. R. Hensel and E. I. Larsen; "Cause and Cure of Intercrystalline Corrosion in Austenitic Steels," J. A. Mathews; "Welding Duralumin," H. S. George; "Spot Welding," Mr. Robertson; "Welding of Extruded Metal," I. T. Hook; "Modern Spot and Relief Welding," P. W. Fassler; and "Machine Gas Welding," J. L. Anderson.

Committee reports will be heard at the board of directors meeting, on April 27 and, as usual, a session will be devoted to the meeting of the American Bureau of Welding, the research department of the society. Professor C. A. Adams, first president of the society, will preside, and the progress reports of the various research committees will be read.

Unusual demonstrations of scientific wonders will take the place of the usual vaudeville entertainment at the annual stag dinner on April 28. O. H. Caldwell, editor of *Electronics*, is scheduled as one of the principal speakers, and dramatic displays of electronic devices will be presented.

States and Cities Accept New Boiler Welding Rules

MANY STATES, territories and cities have signified their intention of adopting the new welding rules embodied in sections I and VIII of the 1931 edition of the A.S.M.E. Boiler Code, according to a recent announcement of the American Uniform Boiler Law Society. Section I of the code permits the fusion welding of drums and shells on power boilers, while Section VIII makes provision for welding unfired pressure vessels.

The following code states and territories, the announcement states, will accept both sections: Indiana, Maryland, Minnesota, New Jersey, Ohio, Oregon, Rhode Island, Utah, Washington, Wisconsin, District of Columbia, Hawaii and Panama Canal Zone. Those that will accept Section I, and have no jurisdiction over Section VIII, are Arkansas, Michigan, New York, Oklahoma and Pennsylvania.

Cities that will accept both sections are Chicago, Ill.; Detroit, Mich.; Evanston, Ill.; and Omaha, Neb.; while those accepting Section I, and having no jurisdiction over Section VIII, are Erie, Pa.; Houston, Tex.; Nashville, Tenn.; Parkersburg, W. Va.; Scranton, Pa.; Seattle, Wash.; St. Louis, Mo.; and Tampa, Fla. Los Angeles, Calif., it is stated, accepts Section I, 1927 Code, and Section VIII, 1931 Code.

Non-code state legislatures meeting this year are Kentucky, Louisiana, Mississippi, Virginia and Georgia. After careful survey of these states, the announcement says, it was thought best not to introduce code legislation in Mississippi or Virgina. Further study is being made in Louisiana and Georgia, and if

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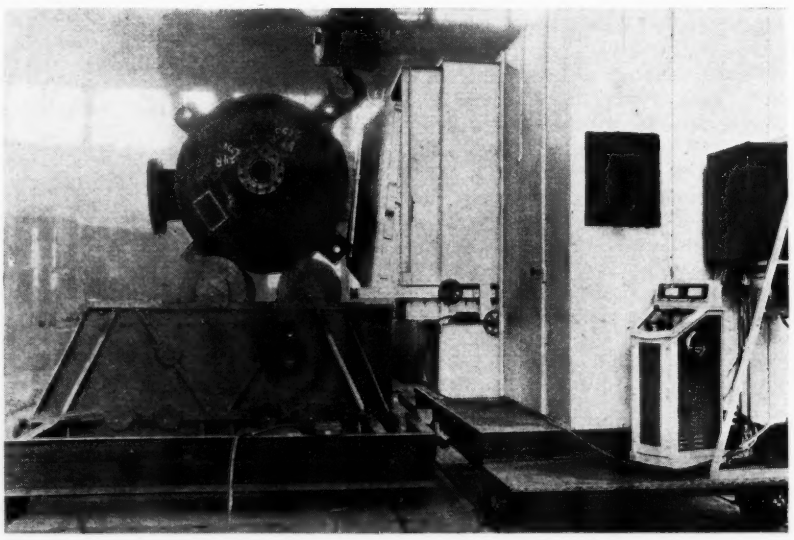
NEW X-RAY INSPECTION MACHINE INSTALLED



A new X-ray machine to examine steel castings and welds has been installed in the Chester (Pa.) plant of the Sun Shipbuilding & Dry Dock Company by the St. John X-Ray Service Corporation. Designed primarily for routine inspection of welded seams in boilers and pressure vessels, according to the A.S.M.E. Code, this installation will also be used to detect defects in other equipment and to train welders

conditions warrant, code bills will be introduced.

A bill has been introduced in Kentucky which has for its purpose the creation of the "Kentucky Industrial Safety Board," the announcement continues. It makes provision for the adoption of the Boiler Code, sections I to VIII inclusive, and is being supported by manufacturers and associated industries.

Governor Roosevelt Vetoes School Ventilating Bill

IN VETOING the Mastick bill to amend the New York State education law in relation to plans and specifications for the ventilation of school buildings, Governor Roosevelt stated on March 28:

"I recognize the desirability of changing the present legal requirements which call for 30 cu.ft. of pure air every minute per pupil in new schools, because since this statute was written we know a great deal more about ventilation. Nevertheless, the present bill would substitute a mere requirement of 'proper ventilation' and would wholly eliminate the requirement of positive facilities, independent of atmospheric changes, for exhausting foul or vitiated air. I am inclined to think that some new standard other than the vague requirement of 'proper ventilation' should be set up and that there should still remain some positive requirement for the exhausting of foul or vitiated air from schoolrooms.

"I hope that during the balance of this year the Department of Education and the Department of Health can work out a change in the law which will meet this purpose. In the meantime, it is necessary to disapprove this bill because it might let down the bars too far."

General Brown Offers Plan To Develop Columbia River

A PROGRAM for improvement of the Columbia River between Vancouver and the mouth of Snake River, at an estimated cost of $16,100,000 with a maintenance and operation cost of $300,000 annually, is recommended by Major-General Lytle Brown, Chief of Army Engineers, in a report submitted to Congress on March 29.

General Brown recommends that the existing project be modified so as to provide for construction by the Federal Government of locks not less than 9 ft. deep over the sills at low water to accommodate modern barge traffic at any dams built under authority of the Federal Water Power Act.

The Columbia River and its tributaries, the report states, are susceptible of being developed into the greatest system of water power at low cost to be found anywhere in the United States. The Board of Engineers for Rivers and Harbors has determined upon ten sites as the most promising, the cost of which development would, it is stated, exceed that of any other single development of any kind for power that has ever been made. The total estimated cost of this 2,000,000-hp. development, including interest at 4 per cent, during construction, would be $711,000,000, and at 6 per cent would be $772,000,000.

General Brown states that he had submitted his report to Dr. Elwood Mead, Commissioner of Reclamation, who, he added, concurs generally with the views

LABORATORY READY FOR EQUIPMENT

With the completion on March 16 of the new hydraulic laboratory at the Bureau of Standards in Washington, D. C., work is about to begin on the installation of equipment. About half of the ultimate pumping capacity will be provided initially by five centrifugal pumps having capacities of 5, 10, 16, 20 and 85 sec.-ft., respectively. Other major equipment for immediate installation includes sluice gates, cranes, constant-level tank and piping. The illustration shows the first floor of the laboratory. Note the inspection doors and openings in the wall of the 12x12x200-ft. main flume at the right

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Transformer Burnout Causes Service Outage in New Haven

INTERRUPTION of all electric service to New Haven, Conn., and adjacent districts was caused late in the afternoon of March 23, when two 5,000-kva. transformers in a substation burned out. The bus at the Grand Avenue generating station failed to clear the trouble and a shutdown resulted. Service was restored to the downtown area in about an hour and to the suburbs by 11:30 p.m.

Investigations by the United Illuminating Company and the Public Utilities Commission have been under way. The city is not interconnected with other systems.

Hartford Mercury Unit Back in Service Again

COMPLETELY RETUBED, the mercury-vapor boiler is again in regular operation at the South Meadow station of the Hartford Electric Light Company, Hartford, Conn. Since being placed on the line March 12, the unit has been functioning satisfactorily. It is regularly delivering electrical energy and 400-lb. steam at the remarkable economy of 9,560 B.t.u. per kilowatt-hour, the over-all rate of the plant being about 12,000 B.t.u.

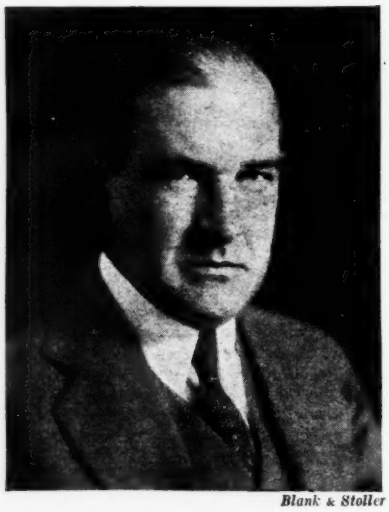
Due to a defect in the tube construction, which caused a slight mercury leak (see *Power*, April 14, 1931, page 605), the unit was taken out of service in March, 1931, after a year of continuous operation. During the shutdown the General Electric Company installed tubes of new design. All other parts of the unit were found to be in a satisfactory condition.

The new tube is definitely fixed in relation to the core, the latter being held in place by six keys running the length of the tube. This confines the mercury vapor definitely in each section and prevents the formation of any hot spots. The tubes have shown no indication of distress under severe firing conditions imposed in the manufacturer's shops. The boiler is now fired with oil from ten burners mounted vertically on a false floor, the former ash section having been removed.

Bernard F. Weadock, New Director of N.E.L.A.

PRESIDENT JAMES F. OWENS announced March 31 the appointment of Bernard F. Weadock, lawyer, as managing director of the National Electric Light Association to succeed Paul S. Clapp, who resigned recently to become vice-president of the Columbia Gas & Electric Corporation.

Mr. Weadock began his career in 1905 in the Corporation Counsel's office of the City of Detroit, Mich., and later



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became Assistant Corporation Counsel, in which capacity he served until 1912. From 1912 to 1920 he was general attorney for the Detroit United Lines and acted as assistant to the president, after which he entered into the general practice of law until 1924, when he came to New York as a member of the law firm of J. C. and B. F. Weadock. He severed his connection with that firm late in 1928 to serve as special counsel for the electric utilities in connection with the Federal Trade Commission's investigation. He will continue to carry on his work before the commission along with the duties of his new office.

New Projects in Canada; Laboratory to Open July 1

PLANS of the newly-formed Central Quebec Light & Power Company contemplate an expenditure of $1,250,000 in the City of Sherbrooke, Quebec, for a 20,000-hp. hydro-eelctric development on the St. Francis River and the erection of a pulp-grinding plant as a subsidiary.

In Vancouver the British Columbia Sugar Refinery is now installing equipment for the elimination of fly-ash from its pulverized-coal plant in the boiler house of its Rogers Street refinery.

Plans for the establishment of a steam stand-by plant at the water works at Brandon, Man., have been dropped by the Brandon City Council following assurance from the Manitoba Power Commission that they will operate two separate high-tension lines to the waterworks plant and further protect against any breakdown by keeping a turbine unit ready at the power plant for emergency service.

Coincident with the 50th anniversary meeting of the Royal Society of Canada in Ottawa, Ont., the early part of July, will be the official opening of the new National Research Laboratories, which the Dominion Government has constructed at a cost of more than $3,000,000 for the National Research Council. Already a program of investigation has been embarked upon in the fields of chemistry, physics, biology, aeronautics, textiles and standardization. The function of the laboratories is to assist in the accurate assessment of Canada's natural resources and seek by the application of science their maximum economic development.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Heaquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Standard Oil Company to Enlarge Its Power System

CONSTRUCTION WORK on the $150,000 project which will connect Standard Oil Company's power plant at Salt Creek with its two refineries near Casper, Wyo., will get under way about April 1, according to officials of the Stearns-Roger Manufacturing Company, Denver, which recently contracted to supply equipment, build the 39-mile transmission line and install substations.

Preliminary surveys have been completed for the high-tension line right-of-way. Specifications call for wood poles and installation of six substations, three at Casper and three at Salt Creek, to handle current at 66,000 volts at point of origin and step it down to 2,300 volts for use at the refineries.

Decreased field operations in Salt Creek makes it possible to apply power resources for Casper refining purposes. Only minor changes will be made at Casper to change over from Mountain States Power Company lines to the new system. The Salt Creek generating station will continue to operate with natural gas-fired equipment.

Personals

JAMES N. LANDIS, assistant mechanical engineer of the Brooklyn Edison Company since 1929, has just been made mechanical engineer. He joined the Edison company in 1923 as technical assistant to the mechanical engineer and subsequently served as plant equipment engineer in charge of generating station engineering and equipment selection.

GEORGE P. TORRENCE was elected president of the Link-Belt Company, Chicago, at the annual meeting of stockholders on March 22. Mr. Torrence has been connected with the company in various capacities for 21 years. As president he succeeds ALFRED KAUFFMAN, who was made vice-president in charge of the Chicago plant.

SIDNEY HOSMER, vice-president and assistant general manager of the Edison Electric Illuminating Company of Boston, has been elected a director of the company to succeed ROBERT SALTONSTALL.

PAUL A. TILLERY, formerly vice-president and general manager of the Carolina Power & Light Company, has been elected president of that company to succeed B. F. JARMIN, resigned. Mr. Tillery entered the power field as superintendent of the Washington (N. C.) municipal electric plant. In 1910 he joined the Carolina Power & Light Company as engineer. Since then he has successively filled the positions of chief engineer, assistant general manager and vice-president and general manager.

Obituary

BERNARD ARTHUR BEHREND, noted consulting engineer and electrical inventor, committed suicide March 25 at his home in Wellesley Hills, Mass. He had been in ill health recently and had been a patient at the Cambridge Hospital. Born at Villeneuve, Switzerland, May 9, 1875, and educated at the Polytechnic Institute of Berlin, Mr. Behrend was the inventor of numerous electrical devices and machinery and designer of large electrical units. He had served as chief designer of the Bullock Electrical Manufacturing Company, of Cincinnati, and as chief electrical engineer and consulting engineer of the Allis-Chalmers Manufacturing Company and Allis-Chalmers-Bullock, Ltd., of Montreal. He had also served as advisory engineer of the Westinghouse Electric & Manufacturing Company. He designed some of the largest electrical units ever manufactured by the Allis-Chalmers and Westinghouse companies.

COL. WILLIAM A. STARRETT, president of the Starrett Corporation and builder of many of America's most celebrated skyscrapers, died on March 26 of a nervous disorder at his home in Madison, N. J. He was 54 years old, a native of Lawrence, Kan. Colonel Starrett entered the construction field with the George A. Fuller Company in New York. He soon left that organization to join his brother, Paul, in the formation of the Thompson-Starrett Company, and from then on was associated with one or the other of his four brothers in building firms which were responsible for the construction of the Empire State Building, Pennsylvania Station in New York, and scores of skyscrapers and hotels in Manhattan.

DR. FRANCIS M. HARTMANN, dean of the School of Engineering, Cooper Union, died March 28 at his home in New York City. Born in Cohocton, N. Y., in 1871, Dean Hartmann graduated from Cooper Union in 1891. For the next few years he worked as an engineer with the City of New York, and following graduate study at New York University, he returned to Cooper Union as an instructor in 1899. He became assistant professor of physics in 1905, professor in 1907, and dean of the engineering school in 1921.

HARRIS T. LUSCOMB, manager of the commercial engineering bureau, contract and inspection department of the New York Edison Company, died of heart failure March 23 at his home in Garden City, L. I. He was 46 years old. After graduating from Columbia University in 1908, Mr. Luscomb joined the Edison company as a special inspector in the contract and inspection department. He was appointed general engineer in the department a few years later and was placed in charge of the newly formed commercial engineering bureau.

How's Business?

THE FISCAL STAGE is now set for further deflation, unless the rapid expansion of Reconstruction Corporation activities and Federal Reserve open market operations can offset its influences. Bank credit contraction continues at about the same drastic rate as in recent months and is reflected in declining business volume and weak commodity prices. A late spring upturn in merchandise freight movement is encouraging, but steel activity, power production (1,514,553,000 kw.-hr. for the week ended March 26, according to the N.E.L.A.) and most other indicators have relapsed to low levels. All eyes are now turned to the intrepid drive of the automobile industry against the deepening depression. — *The Business Week*, April 6.

Business Notes

SARCO COMPANY, INC., New York City, has incorporated a new company, the Spirax Manufacturing Company, Ltd., in London, for the manufacture of Sarco steam traps and other specialties for the British market.

C. O. BARTLETT & SNOW COMPANY, Cleveland, Ohio, announces the transfer of C. W. Ross from the Philadelphia office to New York, where he will be associated with W. H. Norrington, New York manager, in serving the Eastern territory.

HORSBURGH & SCOTT COMPANY, Cleveland, Ohio, announces the opening of a Chicago district sales office at 844 Rush Street. H. G. Davis, C. R. Morrison and R. W. Hoyt will make their headquarters at the new office.

GEARS AND FORGINGS, INC., Cleveland, Ohio, announces appointment of the Carey Machinery & Supply Company, 119-121 East Lombard St., Baltimore, Md., as distributors of its products.

KENNEDY VALVE MANUFACTURING COMPANY, Elmira, N. Y., announces the removal of its Chicago branch office and warehouse to larger and more convenient quarters in the Soo Terminal at 1306-1312 South Canal Street.

MCINTOSH & SEYMOUR CORPORATION, Auburn, N. Y., announces a rearrangement of its Eastern and New England sales districts. The former, comprising the states of New York, Pennsylvania, New Jersey and Connecticut, is now in charge of H. C. Lenfest, with headquarters at 30 Church St., New York City. The New England district, which includes Massachusetts, Maine, New Hampshire, Vermont and Rhode Island, is in charge of F. C. MacKrell, with headquarters also at 30 Church St., New York City.

INTERNATIONAL FILTER COMPANY, Chicago, Ill., and the PEERLESS PUMP COMPANY, Massillon, Ohio, have appointed the Morgan Sales & Service Company, 112 Johnson St., Knoxville, Tenn., as their agents for East Tennessee.

Trade Catalogs

LUBRICATION—A full description of the construction, operation and applications of the new Model "25" force-feed lubricator for cylinders and bearings, is contained in Catalog No. 31 just issued by the Manzel Brothers Company, 326 Babcock St., Buffalo, N. Y. Many illustrations show the different styles adapted to lubricating steam engines and pumps, air and ammonia compressors, machinery bearings, refinery equipment, etc.

ENGINE INDICATORS—Bulletin 3266 of the Bacharach Industrial Instrument Company, 7000-6 Bennett St., Pittsburgh, Pa., describes and illustrates the Maihak indicator for diesel engines. It tells how to determine the correct compression for diesel safety and efficiency and how to detect loss of compression.

MOTORS—Wagner Electric Corporation, 6396 Plymouth Ave., St. Louis, Mo., has just issued illustrated Bulletin No. 174 on squirrel-cage motors. The bulletin describes seven types of these motors, gives application tables, speed-torque curves and complete construction details. It is in loose-leaf form to permit keeping it up to date at all times.

WELDERS, RECORDER—Information on G. E. gas-engine-driven arc welders is contained in a new illustrated folder (GEA-1543) released by the General Electric Company, Schenectady, N. Y. Another recent publication of the company (GEA-1480A) describes the new photoelectric recorder, which will give a graphic record of current, voltage, frequency, temperature, thickness and diameter of various materials, noise, illumination and vibration intensity.

WIRE-ROPE—"12 Reasons Why You Save Money With Lay-Set Preformed Wire Rope" is the title of a new booklet issued by the Hazard Wire Rope Company, Wilkes-Barre, Pa. It presents a comprehensive treatise on the characteristics and applications of wire rope.

ELEVATORS — Detailed specifications and sectional drawings of standard-size passenger elevators are contained in a new folder issued by the Warner Elevator Manufacturing Company, Spring Grove Ave., Alfred and Valley Sts., Cincinnati, Ohio.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Conn., New Milford—S. Boyton Ferriss, 44 West St., awarded contract for construction of a 1 story ice plant to Adams & Hansen, Housatenic Ave. Estimated cost $40,000. Contract for machinery awarded to York Ice Machinery Co., 2nd Ave. and 42nd St., Brooklyn, N. Y.

Conn., West Haven—Hygienic Ice Co., 881 State Pl., New Haven, awarded contract for addition and alterations to ice manufacturing plant on Elm St. here, to Fusco & Amatruda, 59 Amity Road, New Haven. $40,000.

D. C., Washington — Treasury Department, Office of Supervising Architect, awarded contract for four boilers for central heating plant, public buildings to Combustion Engineering Corp., 200 Madison Ave., New York. $426,431.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., having plans prepared for construction of a 1 story transformer house at 35th and South Crawford Sts. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ill., Chicago—Treasury Department, Office of Supervising Architect, Washington, D. C., plans completed for a 3 story addition to marine hospital including boiler plant and laundry at 4141 Clarendon Ave. here. Estimated cost $500,000. Thielbar & Fugard, 520 North Michigan Ave., are architects. C. A. Metz Construction Co., 520 North Michigan Ave., Chicago, is structural engineer.

Ill., Danville—U. S. Veterans' Bureau, c/o G. E. Ijams, Washington, D. C., will receive bids until May 3 for construction of hospital unit No. 1 including refrigeration plant, heating and ventilation systems, pumps, boilers, electric elevators, etc., at Veterans' Administration Home here. Construction Service, 764 Arlington Bldg., Washington, D. C., is architect.

Ia., Sumner—City, voted $95,000 bonds for construction of complete municipal power and light plant. H. L. Cory Co., 1034 Redick Tower, Omaha, Neb., is engineer.

La., New Orleans—Board of Levee Commissioners, Orleans Levee District, 606 Common St., will soon award contract for a group of airport buildings, including 70 x 290 ft. administration, tower and transformer building, 102 x 122 ft. repair shop, 60 x 147 ft. emergency and storage building, two 126 x 197 ft. hangars, etc. $350,000 appropriated. Airport Engineering Corp., Los Angeles, Calif., is engineer.

Mass., Boston — Trimount Dredge Co., 10 State St., plans replacing floating power plant destroyed by fire. Estimated cost $100,000.

Mass., Medfield — Commonwealth of Massachusetts, Hospital Department, having plans prepared for construction of a pump house and standpipe at State Hospital in connection with water supply system. J. J. Van Valkenburgh, Irving Sq., Framingham, is engineer.

Mass., Northampton—Norwood Ice Co., c/o A. F. Grant, Merrick Lane, awarded contract for construction of a 2 story addition to artificial ice plant to Aquadro & Cerrutti, 33 Wilson Ave. Estimated cost $40,000.

Minn., Morris—City plans an election to vote $150,000 bonds for construction of a municipal electric light and power plant. J. A. Mielke is city clerk.

Minn., Willmar—State Commission of Administration & Finance, Capitol, St. Paul, will soon award contract for construction of a deep well, pump house, including installation of centrifugal pump and piping in connection with waterworks at Willmar State Asylum. G. M. Orr & Co., 408 Baker Bldg., Minneapolis, are engineers.

Miss., Charleston—Mayor and Board of Commissioners passed a resolution to purchase or erect electric power plant and waterworks system. Engineer not selected. Present light and water plants owned by Mississippi Power Co.

N. J., Long Branch — Monmouth Memorial Hospital, Third Ave., having sketches made for construction of hospital, interns' quarters, power house and laundry at Third and Pavilion Aves. Estimated cost $150,000. Krumbhaar Burnette & Co. Inc., 115 Broadway, New York, N. Y., are architects and engineers.

N. J., Newark—Owner, c/o Paul C. Reilly, 111 5th Ave., New York, N. Y., Archt., will receive bids after June 1 for construction of a 2 story, 60 x 110 ft. power house and laundry. Estimated cost $40,000.

N. Y., New York—Department of Hospitals, Municipal Bldg., will receive bids after May 1 for construction of a power house, soot collector house, service tunnels, conveyor shaft, etc., at Bellevue Hospital, First Ave. and 28th St. Estimated cost $200,000. C. B. Meyers, 31 Union Sq., is architect. This is preferred project on city construction program and funds are available.

O., Youngstown—City authorized $400,000 bond issue for waterworks improvements including pumps and motors, 500,000 gal. elevated tank, water mains, etc. George Turner, City Hall, is city engineer.

Okla., Ataka—State Board of Affairs, Capitol, Oklahoma City, plans completed for construction of a group of buildings including 60 x 175 ft. power house, 70 x 175 ft. laundry, etc. Estimated total cost $345,000. Layton Hicks & Forsythe, Braniff Bldg., Oklahoma City, are architects.

Okla., El Reno — Department of Justice, Washington, D. C., having plans prepared for construction of a new power house at federal reformatory here. Estimated cost $150,000. Hawk & Parr, First National Bank Bldg., are engineers.

Tenn., Nashville—Board of Public Works, awarded contract for a new 1,000 hp. boiler to Babcock Wilcox Co., 85 Liberty St., New York, stoker, to Riley Stoker Corp. 9 Nepnoset St., Worcester, Mass., for municipal electric light plant. Total cost $29,041.

Utah, Richfield—City, C. Smith, Chn., plans construction of a Diesel electric light plant. Estimated cost $20,000. Engineer not selected.

Wyo., Afton—C. J. Call, Pocatelli, Idaho, has secured permit from State Utilities Commission to build power plant and furnish light and power to Afton and adjoining Star Valley settlements. Estimated cost $30,000. Engineer not selected.

Alta., Calgary—City Commissioners, A. G. Graves, Comr., will soon award contract for construction and completion of a heating and chemical plant, pumping station and screen house for Glenmore Dam, Cont. 12. Contract for water wheels and electrical equipment to Canadian Allis Chalmers Co., 212 King St., Toronto, $76,245; clarifier tanks to Forster Co., 8th Ave. W., Calgary, $20,000; gates and bar-screens to Dominion Bridge Co., Reford Bldg., Toronto, $40,000.

Ont., Hamilton—City, having plans prepared for construction of a sewage pumping station including electrically driven pumps for site near McKittrick bridge. Estimated cost $183,000. W. L. McFaul, Hamilton, is engineer. Work under way on force mains.

Ont., Toronto—Toronto Hydro-Electric System, 225 Yonge St., awarded general contract for constructoin of a 50 x 80 and 50 x 100 ft. electric substation to Joseph Wilde & Co., Canadian Pacific Railroad Bldg. Estimated cost exclusive of equipment $50,000. Owner will purchase and install electrical and sub-station equipment.

Ont., West Lorne—Ratepayers of West Lorne voted for bylaw authorizing construction of waterworks system, including deep wells, electric pumps, distributor mains, etc. Estimated cost $75,000. Ontario Engineering Co., Fort Erie, is engineer.

Equipment Wanted

Fans—New Jersey and New York—Port of New York Authority, 80 8th Ave., New York, will receive bids until April 25 for furnishing and delivering four blower fans and four exhaust fans for approach tunnel at 178th St., New York, for George Washington bridge.

Generator—Salem, Mass.—Pitman & Brown, 40 Bridge St., plans to purchase 25 to 35 kw. a.c. generator, 3 ph., 60 cycle, 220 v.

Pump—Fort Worth, Tex.—City, c/o G. D. Fairtrall, Mgr., will soon receive bids for sludge pump for sewage disposal plant.

Pump, Motor, etc.—East Cleveland, O.—City, C. A. Carran, City Mgr., will soon receive bids for pump, motor, etc., for water storage tank in connection with waterworks.

Pumping Unit—Powell, Wyo.—Town Board authorized the installation of a supplemental pumping unit 50,000 g.p.d. capacity for water supply.

Pumps—London, Ont.—City engineer will receive bids about April 11 for sludge pumps, etc., in connection with extension to East End sewage disposal plant. Estimated cost $46,000.

Pumps, Engine, etc.—Sarnia, Ont.—City plans installation of either one motor driven pump and engine or three pumps varying or graded capacity with Diesel engine standby. $12,000.

Pumps, Motors, etc.—Watertown, Wis.—City Clerk, will receive bids until April 8 for pumps, motors and equipment, etc., in connection with proposed sewage disposal plant.

Switchboard, Generator, etc.—San Francisco, Calif.—Constructing Quartermaster, Fort Mason, receiving bids for switchboard, 100 kw. generator set, 200 kw. turbine and generator, etc., for power plant at Letterman General Hospital.

Transformer Equipment—Alameda, Calif.—C. H. Sweetser, 461 Market St., San Francisco, will receive bids until April 12 for furnishing and installing miscellaneous equipment in transformer station and coast guard disrtibutor house here.

Transformers — Anderson, Ind. — Board of Public Works plans to purchase additional transformers and auxiliary equipment for municipal light plant. $17,000. Appropriation to be made soon.

Industrial Projects

La., Harvey—Continental Can Co., 1 Pershing Sq., New York, N. Y., awarded contract for construction of a 3 story can manufacturing plant to R. P. Farnsworth Co., Inc., Maritime Bldg., New Orleans, $125,000.

Mass., Watertown—Owner, c/o H. L. Kennedy, 89 Boylston St., Boston, awarded contract for construction of a 1 and 2 story, 40 x 150 ft. maintenance plant (electrical), to Thibeau & Comeau, 4 Brattle St., Cambridge. Estimated cost $50,000.

O., Cleveland—William A. Howe Co., 2630 Payne Ave., manufacturers of mountings for lithographs, having preliminary plans prepared for a 2 story factory at East 27th St. Estimated cost $40,000. Julius Boenisch, 4749 Franklin Blvd., is architect.

O., Cleveland — Sabin Machine Co., H. B. Sabin, Pres., 6538 Carnegie Ave., plans construction of a 1 story addition to factory at 6601 Cedar Ave. Estimated cost $40,000. H. M. Morse Co., 736 Prospect Ave., is architect and engineer.

Pa., Brodheadsville—National Portland Cement Co., Finance Bldg., Philadelphia, will build a cement plant, power house and shops here. Estimated cost $2,000,000. Work will be done by separate contracts. Maturity indefinite. A. P. Houser, Emaus, in charge.

Pa., Erie—Erie Casket Co., W. C. Kibler, Pres., 1901 Sassafras St., having plans prepared for construction of a factory. Estimated cost $40,000. Meyers & Johnson, 821 Commerce Bldg., are architects. Mayer & Valentine, 300 Plymouth Bldg., Cleveland, O., are engineers.

Pa., Erie—Hammermill Paper Co., c/o H. Schatain, East Lake Road, will soon award contract for construction of a 1 story, 130 x 260 ft. factory. Estimated cost $100,000. Private plans.

Alta., Edmonton—Van Valkenburg Aircraft Co. Ltd., E. Berg, Pres., plans construction of a plant for the manufacture of airplanes and parts.

Ontario—Eldorado Gold Mines Ltd., 319 Bay St., Toronto, plans construction of a refinery for extraction of radium including crushing, grinding and chemical equipment at Great Bear Lake, Athabaka landing, also establishing barge transportation between deposits and Athabaka landing. Estimated cost to exceed $40,000. A. N. Ochon, c/o owner, is architect.

Ont., Amherstburg—Simrall Refining Corp. of Canada, 814 Union Central Bldg., Cincinnati, O., or c/o J. J. MacLennan, Standard Bank Bldg., Toronto, awarded contract for construction of boiler house and pump house to Pinch & Bailey, 400 Gladstone Ave., Windsor, in connection with petroleum products refinery here. Estimated total cost $100,000.

Ont., London—T. Dexter & Son, Beauford St., plans to rebuild flour mill including electrically operated equipment destroyed by fire.

Ont., Toronto—Owner, c/o B. T. Babbitt Co., 386 4th Ave., New York, N. Y., lessee, manufacturers of lye, etc., plans construction of a plant here, $40,000 including equipment. Lessee will purchase equipment.